

Operating Instructions

Diesel engine
12 V 1600 R50

MS15033/02E



Power. Passion. Partnership.

Engine model	kW/cyl.	Application group
12V1600R50	58 kW/cyl.	2A, Continuous operation, unrestricted

Table 1: Applicability

Table of Contents

1	Safety			
1.1	Important provisions for all products	5		
1.2	Personnel and organizational requirements	7		
1.3	Transportation	8		
1.4	Safety regulations for startup and operation	9		
1.5	Safety regulations for maintenance and repair work	10		
1.6	Fire prevention and environmental protection, fluids and lubricants, auxiliary materials	13		
1.7	Standards for safety notices in the text	15		
2	General Information			
2.1	Engine side and cylinder designations	16		
2.2	Engine overview	17		
2.3	Sensors and actuators - Overview	18		
3	Technical Data			
3.1	Firing order	22		
3.2	Engine - Main dimensions	23		
3.3	12V1600R50 product data	24		
4	Operation			
4.1	Putting the engine into operation after scheduled out-of-service-period	27		
4.2	Putting the engine into operation after extended out-of-service periods (>3 months)	28		
4.3	Starting the engine	29		
4.4	Operational checks	30		
4.5	Engine - Stop	31		
4.6	After stopping the engine	32		
4.7	Plant - Cleaning	33		
4.8	Engine - Barring manually	34		
5	Maintenance			
5.1	Maintenance task reference table [QL1]	36		
6	Troubleshooting			
6.1	Troubleshooting	37		
6.2	Fault messages of engine governor ECU 9 for Series 1600, rail applications	40		
7	Task Description			
7.1	Valve Drive	83		
7.1.1	Valve clearance - Check and adjustment	83		
7.1.2	Cylinder head cover - Removal and installation	86		
7.2	Fuel System	87		
7.2.1	Fuel system - Venting	87		
7.3	Fuel Filter	89		
7.3.1	Fuel filter - Replacement	89		
7.3.2	Fuel prefilter - Drain condensate	91		
7.3.3	Fuel prefilter - Filter element replacement	92		
7.4	Air Filter	93		
7.4.1	Air filter element - Removal and installation (optional)	93		
7.4.2	Air filter element and (optional) dust bowl - Cleaning	94		
7.4.3	Air filter - Replacement (option)	95		
7.5	Air Intake	96		
7.5.1	Service indicator - Signal ring position check	96		
7.6	Lube Oil System, Lube Oil Circuit	97		
7.6.1	Engine oil level - Check	97		
7.6.2	Engine oil - Change	98		
7.7	Oil Filtration / Cooling	99		
7.7.1	Engine oil filter - Replacement	99		
7.8	Coolant Circuit, General, High-Temperature Circuit	100		
7.8.1	Engine coolant - Level check	100		
7.8.2	Engine coolant - Change	101		
7.8.3	Engine coolant - Draining	102		
7.8.4	Engine coolant - Filling	104		
7.8.5	Engine coolant pump - Relief bore check	106		
7.9	Low-Temperature Circuit	107		
7.9.1	Charge-air coolant level - Check	107		
7.9.2	Charge-air coolant - Change	108		
7.9.3	Charge-air coolant - Draining	109		
7.9.4	Charge-air coolant - Filling	110		
7.9.5	Charge-air coolant pump - Relief bore check	112		
7.10	Belt Drive	113		
7.10.1	Coolant pump - Drive belt replacement	113		
7.11	Battery-Charging Generator	115		
7.11.1	Battery-charging generator - Belt tensioner and diverter pulley replacement	115		
7.11.2	Battery-charging generator - Drive belt removal and installation	117		
7.12	Drive Systems, Driving End and Free End (Coupling)	118		
7.12.1	Coupling - Checking (radial / axial) play	118		
7.13	Wiring (General) for Engine/Gearbox/Unit	119		
7.13.1	Engine cabling - Check	119		

7.14 Accessories for (Electronic) Engine Governor / Control System	120	8.2 MTU contact persons/service partners	129
7.14.1 Injector functions	120	9 Appendix B	
7.14.2 Engine governor and connectors - Cleaning	121	9.1 Special Tools	130
7.14.3 Engine governor - Checking plug-in connections	122	9.2 Index	134
7.14.4 NOx sensor - Replacement	123		
7.14.5 Lambda sensor - Replacement	125		
8 Appendix A			
8.1 Abbreviations	127		

1 Safety

1.1 Important provisions for all products

Nameplate

The product is identified by nameplate, model designation or serial number and must match with the information on the title page of this manual.

Nameplate, model designation or serial number can be found on the product.

All EU-certified engines delivered by MTU come with a second nameplate. When operating the machine in the EU: The second nameplate must be affixed in a prominent position as described in the accompanying specifications.

General information

This product may pose a risk of injury or damage in the following cases:

- Incorrect use
- Operation, maintenance and repair by unqualified personnel
- Modifications or conversions
- Noncompliance with the safety instructions and warning notices

Correct use

The product is intended for use in accordance with its contractually-defined purpose as described in the relevant technical documents only.

Intended use entails operation:

- Within the permissible operating parameters in accordance with the (→ Technical data)
- With fluids and lubricants approved by the manufacturer in accordance with the (→ Fluids and Lubricants Specifications of the manufacturer)
- With spare parts approved by the manufacturer in accordance with the (→ Spare Parts Catalog/MTU contact/Service partner)
- In the original as-delivered configuration or in a configuration approved by the manufacturer in writing (including engine control/parameters)
- In compliance with all safety regulations and in adherence with all warning notices in this manual
- With maintenance work performed in accordance with the (→ Maintenance Schedule) throughout the useful life of the product
- In compliance with the maintenance and repair instructions contained in this manual, in particular with regard to the specified tightening torques
- With the exclusive use of technical personnel trained in commissioning, operation, maintenance and repair
- By contracting only workshops authorized by the manufacturer to carry out repair and overhaul

Any other use is considered improper use. Such improper use increases the risk of injury and damage when working with the product. The manufacturer shall not be held liable for any damage resulting from improper, non-intended use.

Modifications or conversions

Unauthorized changes to the product represent a contravention of its intended use and compromise safety.

Changes or modifications shall only be considered to comply with the intended use when expressly authorized by the manufacturer. The manufacturer shall not be held liable for any damage resulting from unauthorized changes or modifications.

Emission regulations and emission labels

Responsibility for compliance with emission regulations

Modification or removal of any mechanical/electronic components or the installation of additional components including the execution of calibration processes that might affect the emission characteristics of the product are prohibited by emission regulations. Emission control units/systems may only be maintained, exchanged or repaired if the components used for this purpose are approved by the manufacturer.

Noncompliance with these regulations will invalidate the design type approval issued by the emissions regulation authorities. The manufacturer does not accept any liability for violations of the emission regulations. The maintenance schedules of the manufacturer must be observed over the entire life cycle of the product.

Replacing components with emission labels

Emission labels are attached to all MTU engines. These must remain on the engine throughout its operational life.

Engines used exclusively in land-based, military applications other than by US government agencies are excepted from this proviso.

Please note the following when replacing components with emission labels:

- Appropriate emission labels must be affixed on spare parts.
- Emission labels may not be transferred from old components to new ones.
- Emission labels on old components must be removed and destroyed.

1.2 Personnel and organizational requirements

Organizational measures of the user/manufacturer

This manual must be issued to all personnel involved in operation, maintenance, repair or transportation.

Keep this manual handy in the vicinity of the product such that it is accessible to operating, maintenance, repair and transport personnel at all times.

Personnel must receive instruction on product handling and maintenance on the basis of this manual with a special emphasis on safety requirements and warnings.

This is particularly important in the case of personnel who only occasionally perform work on or around the product. This personnel must be instructed repeatedly.

Personnel requirements

All work on the product shall be carried out by trained and qualified personnel only:

- Training at the Training Center of the manufacturer
- Qualified personnel specialized in mechanical and plant engineering

The operator must define the responsibilities of the personnel involved in operation, maintenance, repair and transport.

Working clothes and personal protective equipment

Wear proper protective clothing for all work.

When working, always wear the necessary personal protective equipment (e.g. safety footwear, ear protectors, protective gloves, goggles, breathing protection). Observe the information on personal protective equipment in the respective activity description.

1.3 Transportation

Transportation

Only use the lifting eyes provided to lift the engine.

Only use transport and lifting devices approved by MTU.

Take the engine's center of gravity into account.

Lift engines by approx. 10 mm and verify that the lifting ropes / chains between engine and lifting equipment run vertically or in accordance with the specifications on the installation drawing.

If this is not the case, the lifting equipment must be re-adjusted.

The engine must only be transported in installation position, max. permissible diagonal pull 10°.

If the engine is supplied with special aluminum foil packing, lift the engine at the lifting eyes of the bearing pedestal or use a means of transportation which is appropriate for the given weight (forklift truck).

Setting the engine down after transport

Only set down engine on a firm, level surface.

Make sure that the consistency and load-bearing capacity of the ground or support surface is adequate.

Never set an engine down on the oil pan unless expressly authorized to do so by MTU on a case-to-case basis .

1.4 Safety regulations for startup and operation

Safety requirements for startup

Install the product correctly and carry out acceptance in accordance with the manufacturer's specifications before putting the product into service. All necessary approvals must be granted by the relevant authorities and all requirements for initial startup must be fulfilled.

When putting the product into operation, always ensure that

- All personnel is clear of the danger zone surrounding moving parts of the machine. Electrically-actuated linkages may be set in motion when the Engine Control Unit is switched on.
- All maintenance and repair work has been completed.
- All loose parts have been removed from rotating machine components.
- All safety equipment is in place.
- No persons wearing pacemakers or any other technical body aids are present.
- The service room is adequately ventilated.
- Keep clear of the service room during the first operating hours. Hazardous gases may occur as a result of the combustion of paints or oils.
- The exhaust system is leak-tight and that the gases are vented to atmosphere.
- Protect battery terminals, generator terminals or cables against accidental contact.
- Check that all connections have been correctly allocated (e.g. +/- polarity, direction).

Immediately after putting the product into operation, make sure that all control and display instruments as well as the monitoring, signaling and alarm systems are working properly.

Safety requirements for operation

The operator must be familiar with the controls and displays.

The operator must be familiar with the consequences of any operations performed.

During operation, the display instruments and monitoring units must be permanently observed with regard to present operating status, violation of limit values and warning or alarm messages.

Malfunctions and emergency stop

The procedures for emergencies, in particular, emergency stop, must be practiced regularly.

The following steps must be taken if a malfunction of the system is detected or reported by the system:

- Inform supervisor(s) in charge.
- Analyze the message.
- Respond to the emergency appropriately, e.g. execute an emergency stop.

Operation

Do not remain in the operating room when the product is running for any longer than absolutely necessary.

Keep a safe distance away from the product if possible. Do not touch the product unless expressly instructed to do so following a written procedure.

Do not inhale the exhaust gases of the product.

The following requirements must be fulfilled before the product is started:

- Wear ear protectors.
- Mop up any leaked or spilled fluids and lubricants immediately or soak up with a suitable binder agent.

Operation of electrical equipment

When electrical equipment is in operation, certain components of these appliances are electrically live.

Observe the safety instructions for these devices.

1.5 Safety regulations for maintenance and repair work

Safety regulations prior to maintenance and repair work

Have maintenance or repair work carried out by qualified and authorized personnel only.

Allow the product to cool down to less than 50 °C (risk of explosion for oil vapors, fluids and lubricants, risk of burning).

Relieve pressure in fluid and lubricant systems and compressed-air lines which are to be opened. Use suitable collecting vessels of adequate capacity to catch fluids and lubricants.

When changing the oil or working on the fuel system, ensure that the service room is adequately ventilated.

Never carry out maintenance and repair work with the product in operation, unless:

- It is expressly permitted to do so following a written procedure.
- The product is running in the low load range and only for as long as absolutely necessary.

Lock-out the product to preclude undesired starting, e.g.

- Start interlock
- With hydraulic starting system: shut off supply line.

Attach "Do not operate" sign in the operating area or to control equipment.

Disconnect the battery. Lock out circuit breakers.

Close the main valve on the compressed-air system and vent the compressed-air line when air starters are fitted.

Disconnect the control equipment from the product.

Use special tools if they are specified for the relevant work.

Elastomer components (e.g. engine mounts, damping elements, couplings and V-belts) must not be painted. They may only be installed after painting the engine or must be covered before painting work is carried out.

The following applies to starters with copper-beryllium alloy pinions:

- Wear a respirator mask (filter class P3). Do not blow out the interior of the flywheel housing or the starter with compressed air. Clean the flywheel housing inside with a class H dust extraction device.
- Observe the safety data sheet.

Safety regulations during maintenance and repair work

Take special care when removing ventilation or plug screws from the product. Cover the screw or plug with a rag to prevent fluids escaping under pressure.

Take care when draining hot fluids and lubricants (risk of burning).

Use only proper and calibrated tools. Observe the specified tightening torques during assembly or disassembly.

Carry out work only on assemblies or plants which are properly secured.

Make sure components or assemblies are placed on stable surfaces. Adopt suitable measures to avoid that components/tools fall down. Use the specified lifting equipment for all components.

Never use lines for climbing.

Keep fuel injection lines and connections clean.

Carry out appropriate cleaning procedures to clean and inspect components requiring special cleanliness (e.g. components carrying oil, fuel, or air).

Always seal connections with caps or covers if a line is removed or opened.

Fit new seals when re-installing lines.

Avoid damaging lines, particularly the fuel lines.

Ensure that all retainers and dampers are installed correctly.

Ensure that O-rings are not installed in a slanted/twisted condition.

Ensure that all fuel injection and pressurized oil lines are installed with enough clearance to prevent contact with other components. Do not place fuel or oil lines near hot components.

Do not touch elastomeric seals (e.g. Viton sealing rings) with your bare hands if they have a carbonized or resinous appearance.

Note cooling time for components which are heated for installation or removal (risk of burning).

When working high on the engine, always use suitable ladders and work platforms.

Pay particular attention to cleanliness at all times.

Remove any condensate from components which were chilled before assembly. If necessary, coat the components with a suitable corrosion inhibitor.

Safety regulations after completion of maintenance and repair work

Before barring, make sure that nobody is standing in the danger zone of the product.

Check that all access ports/apertures which have been opened to facilitate working are closed again.

Check that all safety equipment has been installed and that all tools and loose parts have been removed (especially the barring gear).

Ensure that no unattached parts have been left in/on the product (e.g. including rags and cable straps).

Welding work

Welding operations on the product or mounted units are not permitted. Cover the product when welding in its vicinity.

Before starting welding work:

- Switch off the power supply master switch.
- Disconnect the battery.
- Separate the electrical ground of electronic equipment from the ground of the unit.

No other maintenance or repair work must be carried out in the vicinity of the product while welding is going on. Risk of explosion or fire due to oil vapors and highly flammable process materials.

Do not use product as ground terminal.

Never position the welding power supply cable adjacent to, or crossing wiring harnesses of the product. The welding current may otherwise induce an interference voltage in the wiring harnesses which could conceivably damage the electrical system.

Remove components (e.g. exhaust pipe) from the product before performing necessary welding work.

Hydraulic installation and removal

Check satisfactory function and safe operating condition of tools, jigs and fixtures to be used. Use only the specified jigs and fixtures for hydraulic removal/installation procedures.

Observe the max. permissible force-on pressure specified for the jig/fixture.

Do not attempt to bend or exert force on HP lines.

Before starting work, pay attention to the following:

- Vent the installation/removal jig, the pumps and the pipework at the relevant designated points.
- During the installation procedure, screw on jig with plunger extended.
- During the removal procedure, screw on jig with plunger retracted.

For a hydraulic installation/removal jig with central expansion pressure supply, screw spindle into shaft end until correct sealing is established.

During hydraulic installation/removal of components, ensure that no persons are in the direct vicinity of the component being pressed.

Working with batteries

Observe the safety instructions of the battery manufacturer when working with batteries.

Gases released from the battery are explosive. Avoid sparks and naked flames.

Do not allow electrolyte to come into contact with skin or clothing.

Wear protective clothing, goggles and protective gloves.

Do not place tools on the battery.

Before connecting the cable to the battery, check the battery polarity. Battery pole reversal may lead to injury through the sudden discharge of acid or bursting of the battery body.

Working on electrical and electronic assemblies

Always obtain the permission of the person in charge before commencing maintenance and repair work or switching off any part of the electronic system required to do so.

De-energize the appropriate areas prior to working on assemblies.

Do not damage cabling during removal work. When reconnecting, ensure that cabling cannot be damaged during operation by:

- Contact with sharp edges
- Chafing on components
- Contact with hot surfaces.

Do not secure cables on lines carrying fluids.

Do not use cable straps to secure cables.

Always use connector pliers to tighten union nuts on connectors.

Subject the device as well as the product to a functional testing on completion of all repair work. In particular, check the function of the engine emergency stop feature.

Store spare parts properly prior to replacement, i.e. protect them against moisture in particular. Package faulty electronic components or assemblies properly before dispatching for repair:

- Moisture-proof
- Shock-proof
- Wrapped in antistatic foil if necessary.

Working with laser devices

When working with laser equipment, always wear special laser-protection goggles (hazard due to heavily focused radiation).

Laser devices must be equipped with protective devices in accordance with their class and usage to ensure safe operation.

For conducting light-beam procedures and measurement work, only the following laser devices may be used:

- Laser devices of classes 1, 2 or 3A.
- Class 3B laser devices:
 - which operate in the visible spectral range (400 nm to 700 nm) only
 - which have a maximum output of 5 mW
 - which are arranged such as to prevent the beam from harming eyesight.

Measuring component deviations

Workpieces, components and measuring equipment are within specified tolerances at a reference temperature of 20 °C.

1.6 Fire prevention and environmental protection, fluids and lubricants, auxiliary materials

Fire prevention

Rectify any fuel or oil leaks immediately. Oil or fuel on hot components can cause fires – therefore always keep the product in a clean condition. Do not leave rags saturated with fluids and lubricants on the product. Do not store combustible materials near the product.

Do not carry out welding work on pipes and components carrying oil or fuel. Before welding, clean with a nonflammable fluid.

When starting the engine with an external power source, connect the ground cable last and remove it first. To avoid sparks in the vicinity of the battery, connect the ground cable from the external power source to the ground cable of the engine or to the ground terminal of the starter.

Always have a suitable extinguishant (fire extinguisher) on hand and familiarize yourself fully with its handling.

Noise

Noise can lead to an increased risk of accidents if acoustic signals, warning shouts or sounds indicating danger are drowned.

Wear ear protectors in workplaces with a sound pressure level in excess of 85 dB (A).

Environmental protection and disposal

Dispose of used fluids, lubricants and filters in accordance with local regulations.

Within the EU, batteries can be returned free of charge to the manufacturer where they will be properly recycled.

Fluids and lubricants, auxiliary materials

The Fluids and Lubricants Specifications will be amended or supplemented as necessary. Prior to operation, make sure that the latest version is used. The latest version can be found on the website on the “Technical Info” or “Parts and Service” tabs at <http://www.mtu-online.com>.

Process materials may also be hazardous or toxic. When using consumables and auxiliary materials as well as other chemical substances, observe the information contained in the safety data sheet for the product. The safety data sheet may be obtained from the relevant manufacturer or from MTU.

Take special care when using hot, chilled or caustic materials.

When using flammable materials, avoid all sparks and do not smoke.

Used oil

Used oil contains combustion residues that are harmful to health.

Rub barrier cream into hands.

Wash hands after contact with used oil.

Lead

- Adopt suitable measures to avoid the formation of lead dust.
- Switch on extraction system.
- When working with lead or pastes containing lead, avoid direct contact to the skin and do not inhale lead vapors.
- Wash hands after contact with lead or lead-containing substances.

Compressed air

Observe special safety precautions when working with compressed air:

- Unauthorized use of compressed air, e.g. forcing flammable liquids (hazard class A1, A2 and B) out of containers, risks causing an explosion.
- Wear goggles when blowing dirt off workpieces or blowing away swarf.
- Blowing compressed air into thin-walled containers (e.g. containers made of sheet metal, plastic or glass) for drying purposes or to check for leaks risks bursting them.
- Pay special attention to the pressure in the compressed air system or pressure vessel.
- Assemblies or products which are to be connected must be designed to withstand this pressure. Install pressure-reducing or safety valves set to the admissible pressure if this is not the case.
- Hose couplings and connections must be securely attached.
- Provide the snout of the air nozzle with a protective disk (e.g. rubber disk).
- First shut off compressed air lines before compressed air device is disconnected from the supply line, or before device or tool is to be replaced.
- Carry out leak test in accordance with the specifications.

Painting

- Observe the relevant safety data sheet for all materials.
- When carrying out painting work outside the spray stands provided with fume extraction systems, ensure that the area is well ventilated. Make sure that neighboring work areas are not adversely affected.
- There must be no naked flames in the vicinity.
- No smoking.
- Observe fire-prevention regulations.
- Always wear a mask providing protection against paint and solvent vapors.

Liquid nitrogen





- Observe the relevant safety data sheet for all materials.
- Work with liquid nitrogen may be carried out only by qualified personnel.
- Store liquid nitrogen only in small quantities and always in specified containers without fixed covers.
- Avoid body contact (eyes, hands).
- Wear protective clothing, protective gloves, closed shoes and safety goggles.
- Make sure that working area is well ventilated.
- Avoid knocking or jolting the containers, valves and fittings or workpieces in any way.

Acids/alkaline solutions/urea (AdBlue[®], DEF)

- Observe the relevant safety data sheet for all materials.
- When working with acids and alkaline solutions, wear goggles or face mask, gloves and protective clothing.
- Do not inhale vapors.
- If urea solution is swallowed, rinse out mouth and drink plenty of water.
- Remove any wet clothing immediately.
- After contact with skin, rinse affected parts of the body with plenty of water.
- Rinse eyes immediately with eye drops or clean tap water. Seek medical attention as soon as possible.

TIM-ID: 0000040536 - 008

1.7 Standards for safety notices in the text

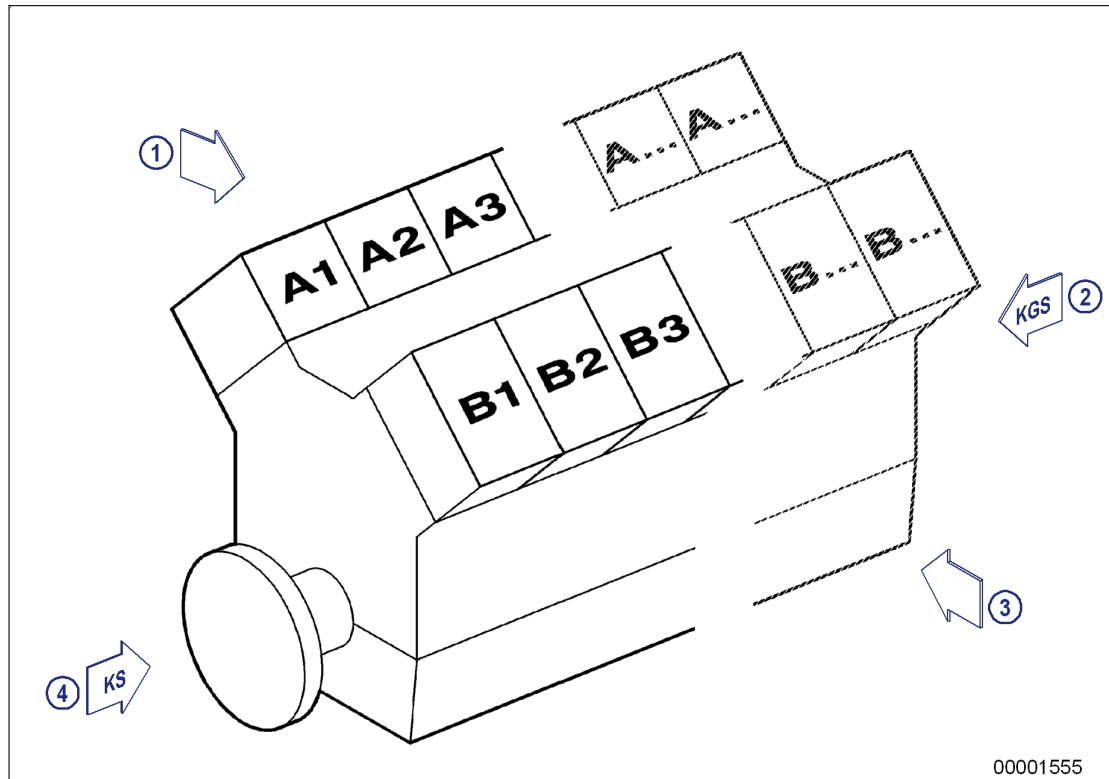
DANGER 	In the event of immediate danger. Consequences: Death, serious or permanent injury! <ul style="list-style-type: none">• Remedial action.
WARNING 	In the event of a situation involving potential danger. Consequences: Death, serious or permanent injury! <ul style="list-style-type: none">• Remedial action.
CAUTION 	In the event of a situation involving potential danger. Consequences: Minor or moderate injuries! <ul style="list-style-type: none">• Remedial action.
NOTICE 	In the event of a situation involving potentially adverse effects on the product. Consequences: Material damage! <ul style="list-style-type: none">• Remedial action.• Additional product information.

Safety notices

1. This manual with all safety instructions and safety notices must be issued to all personnel involved in operation, maintenance, repair or transportation.
2. The higher level warning notice is used if several hazards apply at the same time. Warnings related to personal injury shall be considered to include a warning of potential damage.

2 General Information

2.1 Engine side and cylinder designations



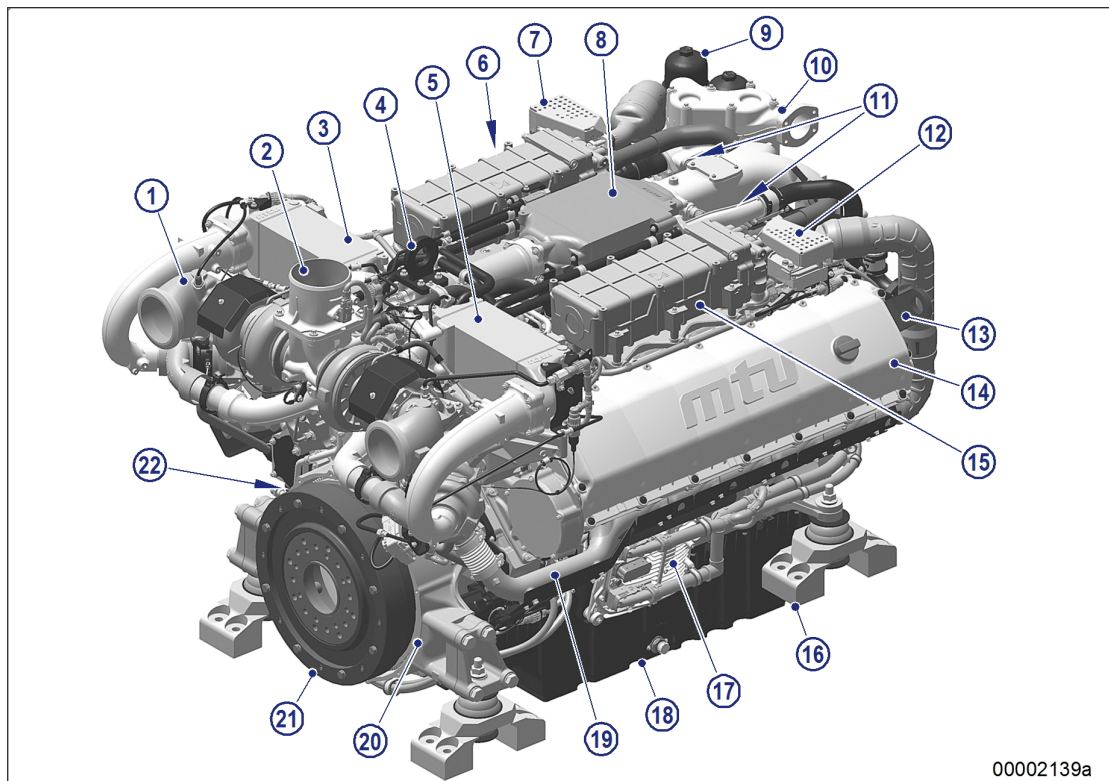
- | | |
|--|---|
| 1 Left engine side (A-side) | 3 Right engine side (B-side) |
| 2 Engine free end in accordance with DIN ISO 1204 (KGS = Kupplungsgegen-seite) | 4 Engine driving end in accordance with DIN ISO 1204 (KS = Kup-plungsseite) |

Engine sides are always designated (in accordance with DIN ISO 1204) as viewed from driving end (4).

For cylinder designation (in accordance with DIN ISO 1204), the letter "Ax" refers to the cylinders on the left-hand side of the engine (1) and letter "Bx" refers to the cylinders on the right-hand side (3). The cylinders of each bank are numbered consecutively, starting with x=1 at driving end (4).

The numbering of other engine components also starts with 1 at driving end (4).

2.2 Engine overview



00002139a

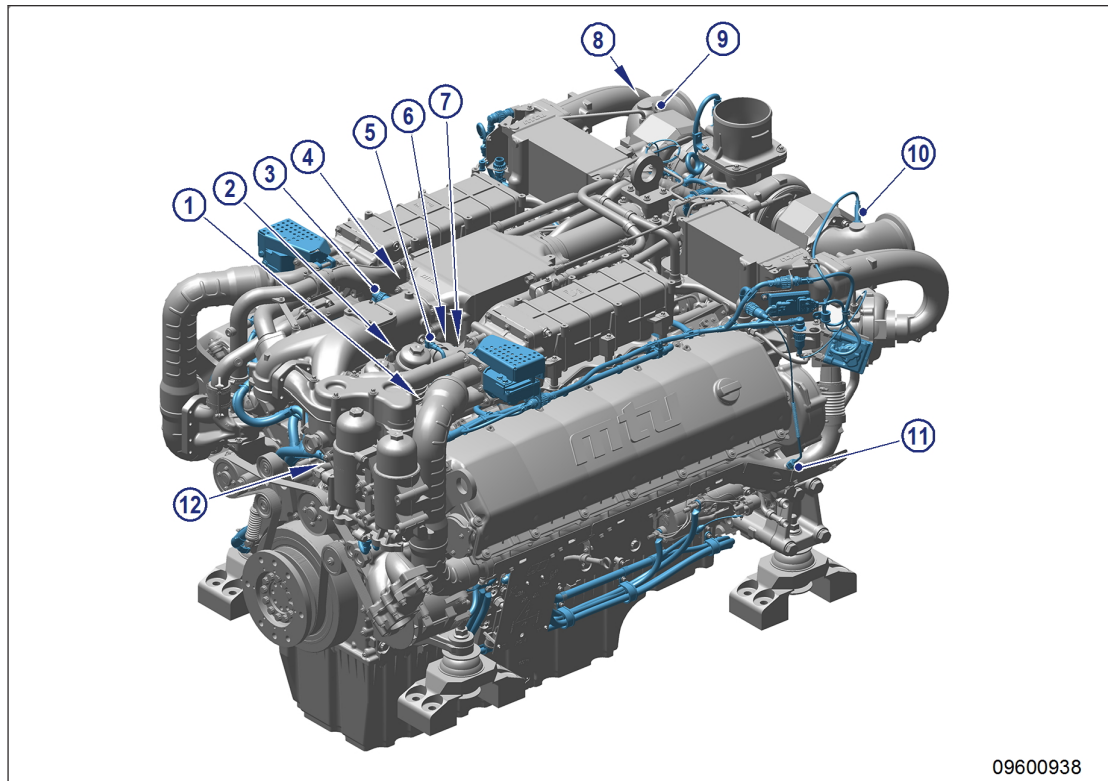
- | | | |
|------------------------------|-------------------------------|---------------------|
| 1 Exhaust outlet | 9 Fuel filter | 17 Engine governor |
| 2 Air intake | 10 Thermostat housing | 18 Oil pan |
| 3 Intermediate intercooler | 11 Oil filter | 19 Exhaust elbow |
| 4 Lifting eye, driving end | 12 EGR flap before EGR cooler | 20 Flywheel housing |
| 5 Intermediate intercooler | | 21 Coupling |
| 6 Oil dipstick | 13 Lifting eye, free end | 22 Starter |
| 7 EGR flap before EGR cooler | 14 Cylinder head | |
| 8 Intercooler | 15 EGR cooler | |
| | 16 Engine mount | |

Engine model designation

Key to the engine model designations 12 V 1600 Rxy

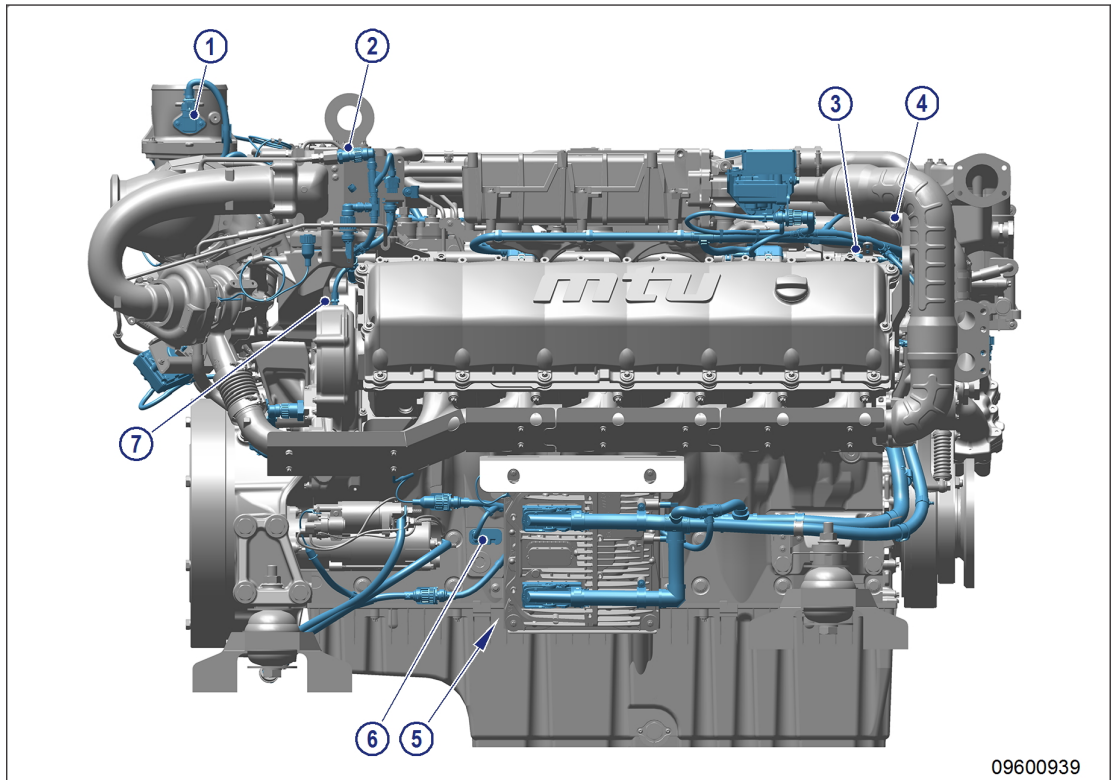
12	Number of cylinders
V	Cylinder arrangement: V engine
1600	Series
R	Application
x	Application segment
y	Design index

2.3 Sensors and actuators – Overview

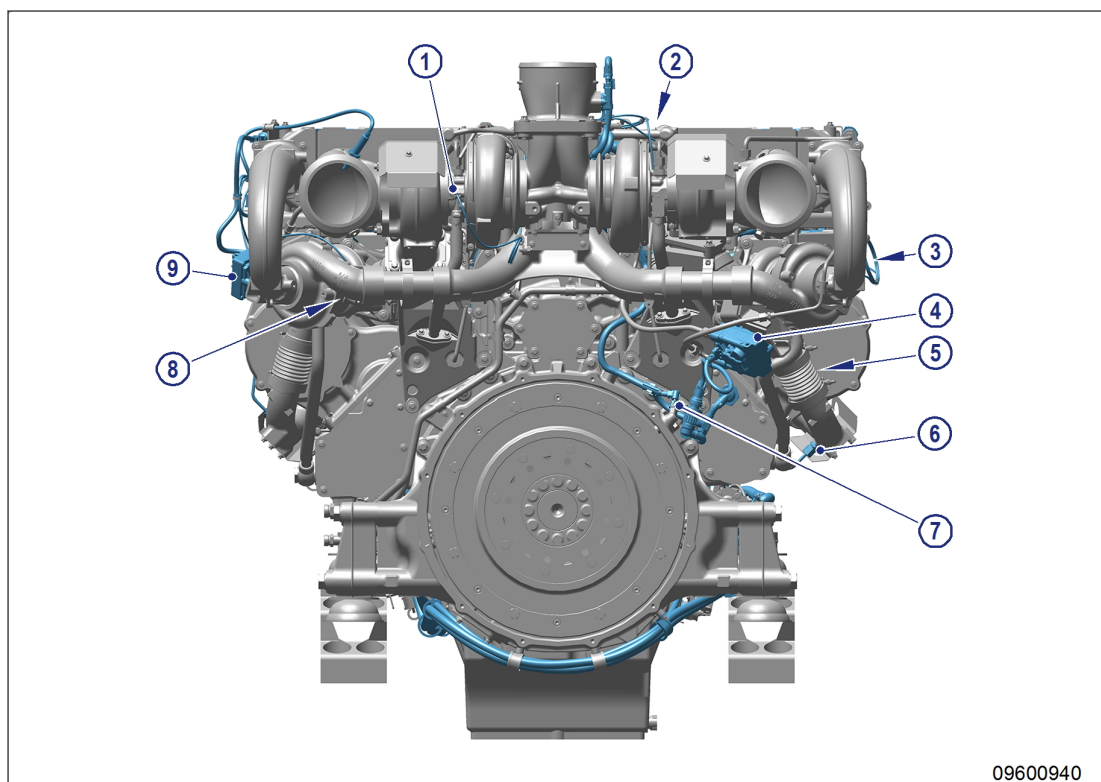


Item	Name	Description
1	B48.1	Fuel pressure in HP system, HP line, left side
2	B10	Charge-air pressure
3	B5.1	Lube oil pressure after filter
4	B9.3	Charge-air temperature after exhaust gas recirculation, right side
5	B9.1	Charge-air temperature before exhaust gas recirculation
6	B9.2	Charge-air temperature after exhaust gas recirculation, left side
7	B5.3	Lube oil pressure before filter (option)
8	B88.2	NOx sensor, right side (nitrogen oxide levels in exhaust gas)
9	B89	Lambda sensor (residual oxygen content in exhaust gas)
10	B88.1	NOx sensor, left side (nitrogen oxide levels in exhaust gas)
11	B4.2.1	Exhaust temperature, left side
12	B6.1	Engine coolant temperature

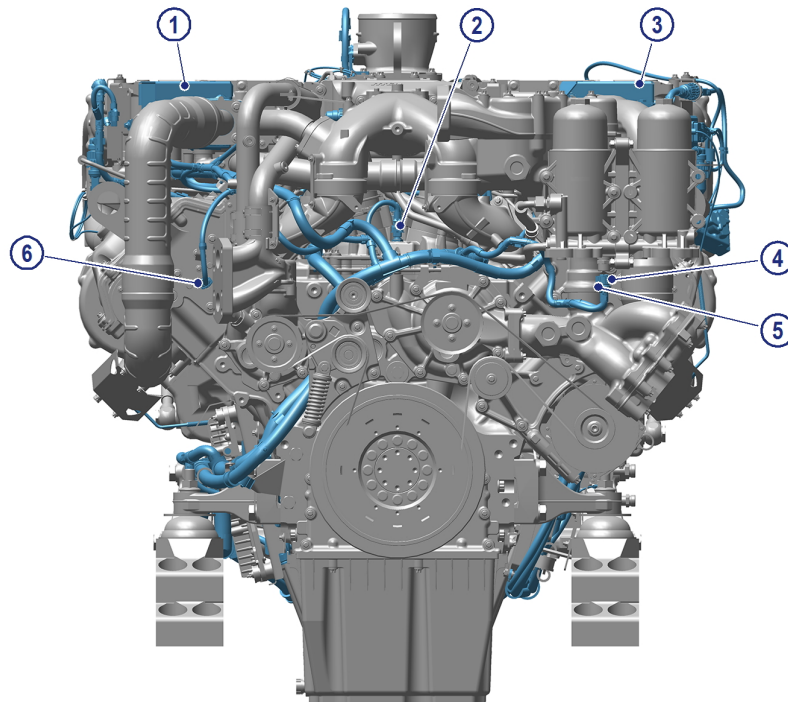
TMA-ID: 0000035485 - 004



Item	Name	Description
1	B90	Humidity, pressure, temperature of intake air
2	B91.3	Exhaust gas pressure
3	B48.2	Fuel pressure in HP system, HP line, right side
4	B26	Charge air coolant temperature
5	B93	Lube oil level and temperature (option)
6	A19	EIL (Engine Ident Label)
7	B1	Camshaft speed



Item	Name	Description
1	B44.3	Speed of LP turbocharger, left side
2	B44.4	Speed of LP turbocharger, right side
3	B44.2	Exhaust turbocharger (high pressure) speed, right side
4	M52.2	Bypass flap of HP turbocharger, right side
5	B50	Crankcase pressure (option)
6	B4.22	Exhaust temperature, ritght side
7	B13	Crankshaft speed
8	B44.1	Speed of HP turbocharger, left side
9	M52.1	Bypass flap of HP turbocharger, left side



09600941

Item	Name	Description
1	M53.2	EGR shut-off flap before cooler, right side
2	B7	Lube oil temperature
3	M53.1	EGR shut-off flap before cooler, left side
4	B34.1	Fuel pressure after filter
5	B34.2	Fuel pressure before filter (option)
6	B6.3	Engine coolant temperature in cylinder head

3 Technical Data

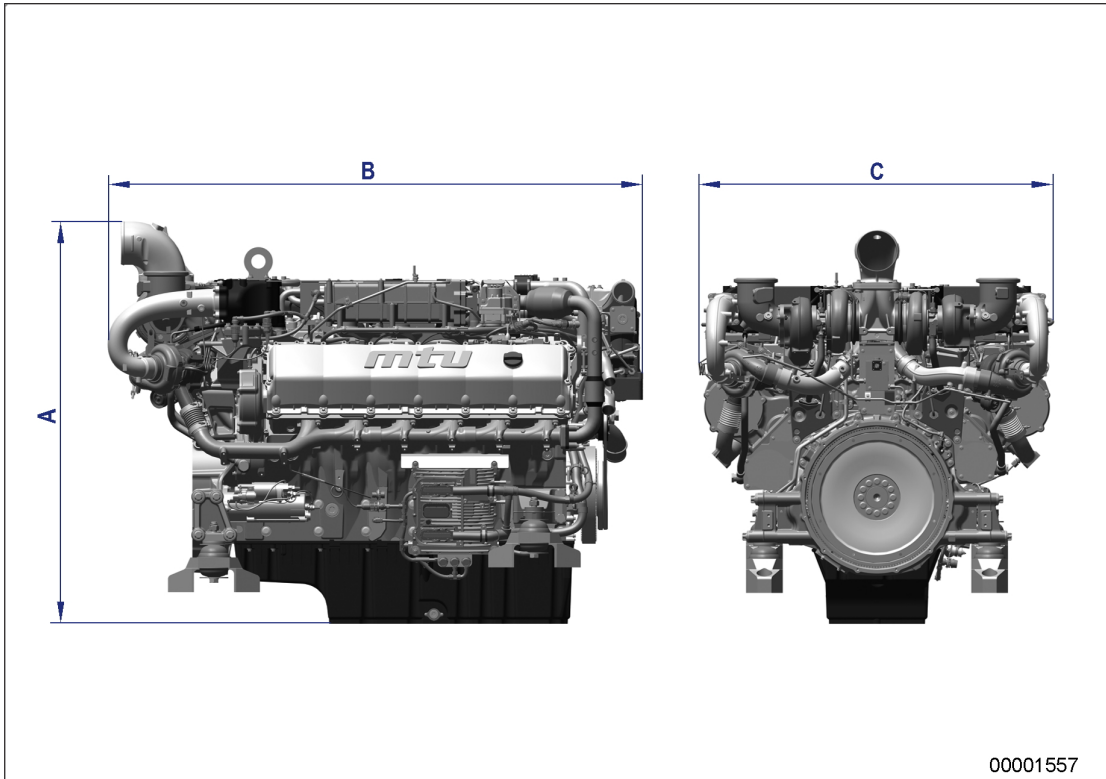
3.1 Firing order

12 V	A1-B2-A5-B4-A3-B1-A6-B5-A2-B3-A4-B6
------	-------------------------------------

Direction of rotation

Direction of rotation (as viewed on driving end)	c.c.w., not reversible
--	------------------------

3.2 Engine - Main dimensions



Item	Dimensions
Length (B)	approx. 1871 mm
Width (C)	approx. 1228 mm
Height (A)	approx. 1327 mm

3.3 12V1600R50 product data

Legend

- DL Ref. value: Continuous power. Continuously attainable power at standard conditions.
- BL Ref. value: Fuel stop power. Maximum engine power. Not continuously attainable in some applications (margin for load fluctuations).
- A Design value. Value is used for the design of an external system (plant).
- R Guideline value. Typical average value for information, limited suitability for design purposes.
- L Limit value. Value which must not be fallen short of (lower limit, min. value) or exceeded (upper limit, max. value), not suitable for design purposes.
- N Not yet defined value. Value has not yet been defined or will not be defined.
- Not applicable. Assembly applies to the given product type.
- X Applicable. Assembly applies to the given product type.
- > The actual value must be greater than the specified value.
- < The actual value must be smaller than the specified value.
- * Not sufficiently validated value (+/- 10% tolerance).
- ** Not sufficiently validated value (+/- 5% tolerance).

ID	Produkttyp (Product type)	Application	Engine speed	Effective power	
1	12V1600R50	Rail main drive 2A continuous operation, unrestricted	1900 1/min	690 kW	Ref. 25°C/45°C EU "Nonroad" Stage IIIB (97/68/EC)

Reference conditions

ID			1
Intake air temperature		°C	25
Charge air coolant temperature		°C	45
Barometric pressure		mbar	981
Site altitude above sea level		M	400

Performance data

ID			1
Rated engine speed	A	rpm	1900
UIC rated power (fuel stop power ISO 3046)	A	kW	690

General conditions (for maximum power)

ID			1
Intake depression (new filter)	A	mbar	25
Intake depression, max.	L	mbar	35
Fuel temperature at engine inlet connection, max (w/o power reduction)	L	°C	70

Consumption

ID			1
Specific fuel consumption (be) - Best point (+5%; EN 590; 42.8MJ/kg)	R	g/kWh	191

T1M-ID: 0000035558 - 004

Model-related data (basic design)

ID			1
Number of cylinders	-		12
Cylinder arrangement: V-angle		Degrees (°)	90
Bore		mm	122
Stroke		mm	150
Displacement, cylinder		Liters	1.75
Displacement, total		Liters	21
Compression ratio	-		17.7
Number of inlet valves per cylinder	-		2
Number of exhaust valves per cylinder	-		2

Combustion air / exhaust gas

ID			1
Exhaust temperature after turbocharger	R	°C	415

Coolant system (high-temperature circuit)

ID			1
Coolant temperature (at engine connection: outlet to cooling equipment)	A	°C	95
Coolant temperature after engine, shutdown	L	°C	112
Coolant pump: Inlet pressure, max.	L	bar	2.5
Thermostat: Starts to open	R	°C	79
Thermostat: Fully open	R	°C	92

Coolant system (low-temperature circuit)

ID			1
Coolant pump: Inlet pressure, max.	L	bar	2.5
Thermostat: Starts to open	R	°C	30
Thermostat: Fully open	R	°C	45

Lube oil system

ID			1
Lube-oil temperature before engine, shutdown	L	°C	130

Fuel system

ID			1
Fuel pressure at engine inlet connection, min. (when engine is starting)	L	bar	-0.65

Oil and Coolant Capacity

ID			1
Engine coolant capacity, engine side (without cooling equipment)	R	Liters	60
Charge-air coolant, engine side	R	Liters	15

ID			1
Engine oil capacity, initial filling (standard oil system) (Option: max. operating inclinations)	R	Liters	75
Oil change quantity, max. (standard oil system) (Option: max. operating inclinations)	R	Liters	71
Oil pan capacity at dipstick mark "min." (standard oil system) (Option: max. operating inclinations)	L	Liters	58
Oil pan capacity at dipstick mark "max." (standard oil system) (Option: max. operating inclinations)	L	Liters	65

Weights / main dimensions

ID			1
Dry engine weight (basic-configuration engine)	R	kg	2290

Acoustics

ID			1
Exhaust noise, unsilenced - BL (free-field sound-pressure level Lp, 1 m distance, ISO 6798, +3dB(A) tolerance)	R	dB(A)	107
Engine surface noise w/o intake noise - BL (free-field sound pressure level Lp, 1 m distance, ISO 6798, +2 dB(A) tolerance)	R	dB(A)	99

4 Operation

4.1 Putting the engine into operation after scheduled out-of-service-period

Preconditions

- ☒ Engine is stopped and starting disabled.

Startup

Item	Action
Lube oil system	Check engine oil level (→ Page 97).
Coolant circuit	Check engine coolant level (→ Page 100); Check charge-air coolant level (→ Page 107).
Coolant circuit	Preheat engine coolant with coolant preheating unit (if fitted).
Fuel prefilter	Drain fuel prefilter (→ Page 91).
Engine control system	Switch on.

4.2 Putting the engine into operation after extended out-of-service periods (>3 months)

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ MTU Preservation and Represervation Specifications (A001070/..) are available.



Putting the engine into operation after extended out-of-service periods (>3 months)

Item	Action
Engine	Depreserve (→ MTU Preservation and Represervation Specifications A001070/..).
Lube oil system	Check engine oil level (→ Page 97).
Fuel system	Vent (→ Page 87).
Coolant circuit	If engine is out of service for more than one year, change engine coolant (→ Page 101). Change charge-air coolant (→ Page 108).
Coolant circuit	Check engine coolant level (→ Page 100); Check charge-air coolant level (→ Page 107).
Coolant circuit	Preheat engine coolant with coolant preheating unit (if fitted).
Engine governor	Check plug-in connections (→ Page 122).
Engine control system	Switch on.

4.3 Starting the engine

Preconditions

- ☒ Engine is not connected to load.
- ☒ External start interlock is not active.

DANGER 	Rotating and moving engine parts. Risk of crushing, danger of parts of the body being caught or pulled in! <ul style="list-style-type: none">• Before cranking the engine with starter system, make sure that there are no persons in the engine's danger zone.
WARNING 	High level of engine noise when the engine is running. Risk of damage to hearing! <ul style="list-style-type: none">• Wear ear protectors.

Starting engine

Item	Action
Switchgear cabinet, operator station etc. (depending on manufacturer)	Press start button. <ul style="list-style-type: none">• Automatic starting sequence is executed.• Tachometer indicates increasing speed.• After the starting procedure is completed, engine is running at idle speed.

4.4 Operational checks

DANGER



Rotating and moving engine parts.

Risk of crushing, danger of parts of the body being caught or pulled in!

- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING



High level of engine noise when the engine is running.

Risk of damage to hearing!

- Wear ear protectors.

Operational checks

Item	Action
Control and display panels	Check readings of operational data (speed, temperature, pressures).
Engine oil	Check engine oil level (→ Page 97).
Engine operation	Check engine visually for leaks and general condition; Check engine for abnormal running noises, exhaust color and vibrations (→ Page 37).
Air filter	Check filter restriction indicator on the air filter (if fitted) (→ Page 96).
Exhaust gas system	Check exhaust color (→ Page 37).
Engine coolant pump	Check relief bore (→ Page 106).
Charge-air coolant pump	Check relief bore (→ Page 112).

4.5 Engine - Stop

Preconditions

- ☑ Engine is not connected to load

NOTICE



Stopping the engine when it is running at full load subjects it to extreme thermal and mechanical stresses.

Overheating of and, therefore, damage to components is possible!

- Before shutting down the engine, allow it to idle until the engine temperatures decrease and constant levels are indicated.

Stopping engine

Item	Action
Temperature indications	Wait until engine temperatures are constant.
Switchgear cabinet, operator station etc. (depending on manufacturer)	Press stop button. <ul style="list-style-type: none">• Automatic stopping procedure is performed.• Engine at a standstill.

4.6 After stopping the engine

Preconditions

☑ MTU Preservation and Represervation Specifications (A001070/..) are available.

NOTICE



Coolant sensors may freeze if there is a risk of frost.

Risk of sensor damage!

- Protect sensors from frost.

After stopping the engine

Item	Action
Coolant circuit	Drain engine coolant (→ Page 102); Drain charge-air coolant (→ Page 109) if: <ul style="list-style-type: none">• freezing temperatures are expected and the engine is to remain out of service for an extended period, but engine coolant has no antifreeze additive;• the engine room is not heated;• the coolant is not kept at a suitable temperature;• the antifreeze concentration is insufficient for the engine-room temperature;• antifreeze concentration is 50 % and engine-room temperature is below -40°C.
Engine control system	Switch off.
Air intake and exhaust systems	Out-of-service-period > 1 week: <ul style="list-style-type: none">• Seal engine's air and exhaust gas openings. Out-of-service-period > 1 month: <ul style="list-style-type: none">• Carry out engine preservation (→ MTU Preservation and Represervation Specifications A001070/..).

4.7 Plant – Cleaning

Preconditions

- ☒ Engine is stopped and starting disabled.
- ☒ No operating voltage is applied.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Steam jet cleaner	-	1
Cleaner (Hakupur 50/136)	X00056700	1

WARNING



Compressed air gun ejects a jet of pressurized air.

Risk of injury to eyes and damage to hearing, risk of rupturing internal organs!

- Never direct air jet at people.
- Always wear safety goggles/face mask and ear defenders.

WARNING



Water jet from high-pressure cleaning unit.

Risk of eye injury, risk of scalding!

- Do not direct water jet at persons.
- Wear protective clothing, protective gloves, and goggles/safety mask.

NOTICE



Cleaning agents should not be left to take effect for too long.

Damage to components is possible!

- Observe manufacturer's instructions.

NOTICE



Blowing down product with compressed air.

Entry of dirt and damage to components is possible!

- Do not aim compressed air gun directly at seals or electronic components such as connectors or ECUs.

Plant – Cleaning

1. Carry out plant cleaning only in areas where an appropriate oil separator is provided (environmental protection).
 2. Prior to putting the cleaning unit into operation, read the operating instructions of the water/steam jet unit carefully and observe the safety precautions.
 3. For external cleaning of the plant with water or steam-jet cleaners:
 - The pressure of the high-pressure jet (cleaning jet) must not exceed 50 bar.
 - A minimum distance between spray nozzle and plant of 1 m must be observed.
 - The temperature of the cleaning medium must not exceed 80 °C.
 4. For external cleaning with high-pressure jet, use a flat-mouth nozzle only.
- Note: Never direct compressed air directly at electronic components.
5. Carry out external cleaning as follows:
 - a) Seal all openings in a suitable way.
 - b) Remove coarse dirt.
 - c) Spray on cleaner sparingly and leave it for 1 to 5 minutes.
 - d) Use the high-pressure jet to remove the loosened dirt.
 - e) Dry engine with compressed air.

4.8 Engine – Barring manually

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Barring device	F6790714	1
Barring device	F6797426	1
Adapter	F30011619	1
Ratchet adapter	F30027340	1

DANGER



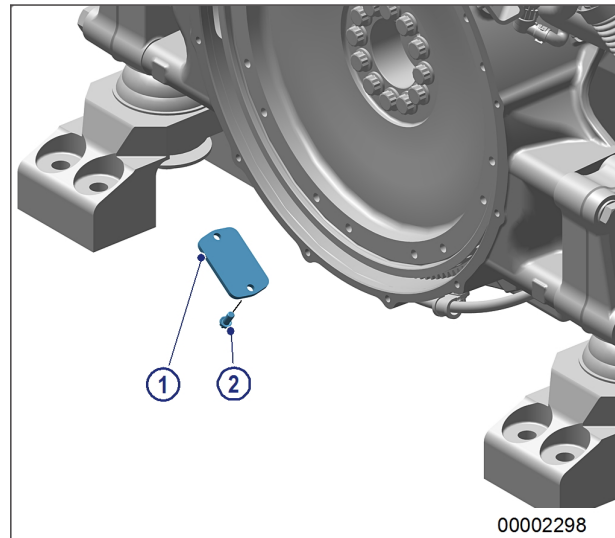
Rotating and moving engine parts.

Risk of crushing, danger of parts of the body being caught or pulled in!

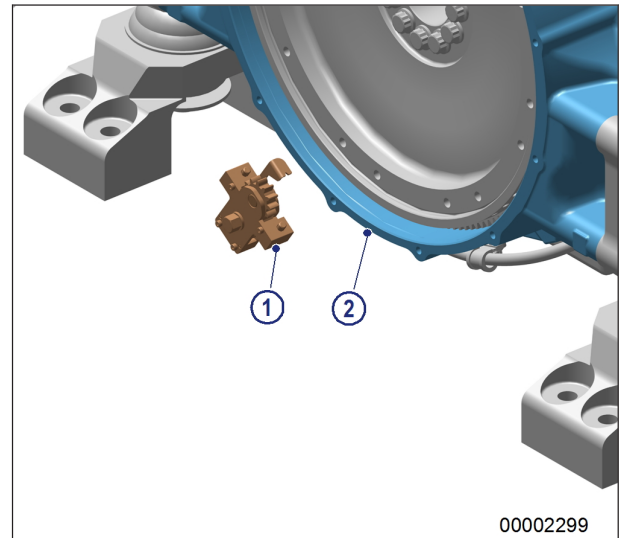
- Before cranking the engine with starter system, make sure that there are no persons in the engine's danger zone.

Barring engine manually – Variant A

1. Remove screw (2) on flywheel housing.
2. Remove end cover (1).

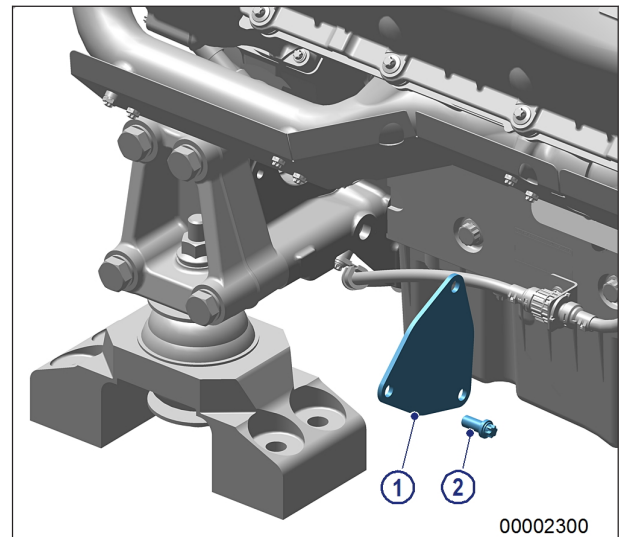


3. Engage barring device (1) in ring gear and install on flywheel housing (2).
4. Fit adapter and ratchet adapter on barring device.
5. Rotate crankshaft in engine direction of rotation. Apart from the normal compression resistance, there should be no resistance.
6. For barring device removal, follow reverse sequence of working steps.

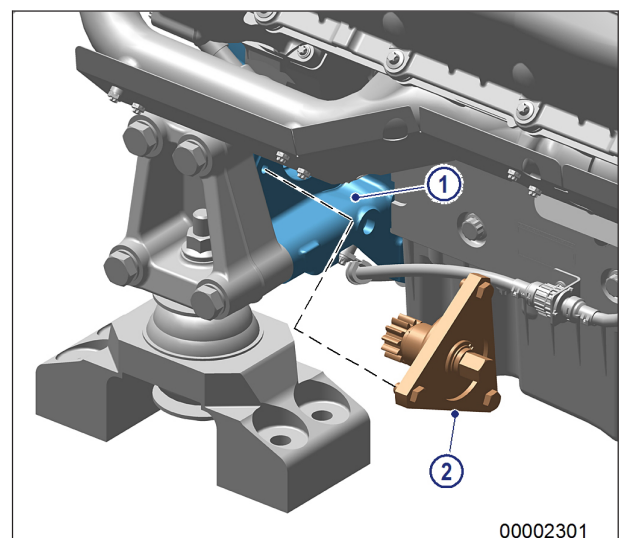


Barring engine manually – Variant B

- Note: Remove starter if necessary.
1. Remove screw (2) on flywheel housing.
 2. Remove end cover (1).



3. Engage barring device (2) in ring gear and install on flywheel housing (1).
4. Fit adapter and ratchet adapter on barring device.
5. Rotate crankshaft in engine direction of rotation. Apart from the normal compression resistance, there should be no resistance.
6. For barring device removal, follow reverse sequence of working steps.



5 Maintenance

5.1 Maintenance task reference table [QL1]

The maintenance tasks and intervals for this product are defined in the Maintenance Schedule. The Maintenance Schedule is a stand-alone publication.

The task numbers in this table provide reference to the maintenance tasks specified in the Maintenance Schedule.

Task	Option	Maintenance tasks	
W0500		Check engine oil level.	(→ Page 97)
W0503	X	Check service indicator of air filter.	(→ Page 30)
W0506		Check engine for abnormal running noises, exhaust color and vibrations.	(→ Page 30)
W0507		Drain water and contaminants from fuel prefilter.	(→ Page 30)
W1001		Replace fuel filter or fuel filter element	(→ Page 89)
W1005	X	Replace air filter.	(→ Page 95)
W1008		Replace engine oil filter when changing engine oil, or when the interval (years) is reached, at the latest.	(→ Page 99)
W1013		Replace drive belt.	(→ Page 113)
W1019	X	Check radial play.	(→ Page 118)
W1027	X	Clean air filter, empty dust bowl.	(→ Page 94)
W1207		Check valve clearance, adjust as necessary. ATTENTION! First adjustment after 1,000 operating hours.	(→ Page 83)
W1326	X	Replace battery-charging generator belt tensioner and diverter pulley.	(→ Page 115)
W1525		Replace sensor.	(→ Page 123)
W1526		Replace sensor.	(→ Page 125)
W1636		Reset drift correction parameters (CDC) and enter injector coding (IIG).	(→ Page 120)
W1675		Replace fuel prefilter or fuel prefilter element.	(→ Page 92)

Table 2: Maintenance task reference table [QL1]

6 Troubleshooting

6.1 Troubleshooting

Engine does not turn when starter is actuated

Cause	Corrective action
Battery low or faulty	► Charge or replace (→ manufacturer's documentation).
Battery: Cable connections faulty	► Check if cable connections are properly secured (→ manufacturer's documentation).
Starter: Engine cabling or starter faulty	► Check if cable connections are properly secured, contact Service.
Engine wiring defective	► Check (→ Page 119).
Connectors on engine governor possibly loose	► Check plug connections (→ Page 122).
Running gear blocked (engine cannot be barred manually)	► Contact Service.

Engine turns but does not fire

Cause	Corrective action
Poor rotation by starter: Battery low or faulty	► Charge or replace battery (→ manufacturer's documentation).
Engine wiring defective	► Check (→ Page 119).
Air in fuel system	► Vent fuel system (→ Page 87).
Engine governor defective	► Contact Service.

Engine fires unevenly

Cause	Corrective action
Injector defective	► Contact Service.
Engine wiring defective	► Check (→ Page 119).
Air in fuel system	► Vent fuel system (→ Page 87).
Engine governor defective	► Contact Service.

Engine does not reach rated speed

Cause	Corrective action
Fuel prefilter (if fitted) clogged.	► Clean or replace filter element (→ manufacturer's documentation).
Fuel filter clogged	► Replace (→ Page 89).
Air filter clogged	► Replace air filter (→ Page 95)
Injector defective	► Contact Service.
Engine wiring defective	► Check (→ Page 119).
Engine: Overloaded	► Contact Service.

Engine speed not steady

Cause	Corrective action
Injector defective	► Contact Service.
Speed transmitter defective	► Contact Service.
Air in fuel system	► Vent fuel system (→ Page 87).
Engine governor defective	► Contact Service.

Charge air temperature too high

Cause	Corrective action
Engine coolant treatment incorrect	► Check (MTU test kit).
Intercooler clogged	► Contact Service.
Engine room: Air-intake temperature too high	► Check fans and intake/exhaust lines.

Charge-air pressure too low

Cause	Corrective action
Air filter clogged	► Replace air filter .(→ Page 95)
Intercooler clogged	► Contact Service.
Exhaust turbocharger defective	► Contact Service.

Coolant leaks at intercooler

Cause	Corrective action
Intercooler leaky, major coolant discharge	► Contact Service.

Black exhaust gas

Cause	Corrective action
Air filter clogged	► Replace air filter .(→ Page 95)
Injector defective	► Contact Service.
Engine: Overloaded	► Contact Service.

Blue exhaust gas

Cause	Corrective action
Too much oil in engine	► Drain engine oil (→ Page 98).
Exhaust turbocharger, cylinder head, piston rings, cylinder liner defective	► Contact Service.

TTM-ID: 0000054488 - 001

White exhaust gas

Cause	Corrective action
Engine is not at operating temperature	▶ Run engine to reach operating temperature.
Water in fuel	▶ Check fuel system on fuel prefilter; Drain fuel prefilter (→ Page 91).
Intercooler leaky	▶ Contact Service.

6.2 Fault messages of engine governor ECU 9 for Series 1600, rail applications

3 – HI T-Fuel

ZKP-Number: 2.0122.931

Yellow alarm; warning

Cause	Corrective action
Fuel temperature too high.	► Reduce power.

4 – SS T-Fuel (Limit 2)

ZKP-Number: 2.0122.932

Red alarm; power limitation $\geq 20\%$; forced idle

Cause	Corrective action
Fuel temperature too high.	1. Acknowledge alarm. 2. Request towing locomotive if required.

5 – HI T-Charge Air

ZKP-Number: 2.0121.931

Yellow alarm; warning

Cause	Corrective action
Charge-air temperature too high.	1. Reduce power. 2. If fault code number 9 is signaled at the same time, then it has priority.

6 – SS T-Charge Air (Limit 2)

ZKP-Number: 2.0121.932

Yellow alarm; power limitation $< 20\%$;

Cause	Corrective action
Charge-air temperature too high.	1. Reduce power. 2. If fault code number 9 is signaled at the same time, then it has priority.

9 – HI L1 T-Coolant Intercooler

ZKP-Number: 2.0124.931

Yellow alarm; warning

Cause	Corrective action
Coolant temperature in intercooler too high.	1. Reduce power. 2. Check engine lines for leaks. Check coolant cooler for leaks, contamination and operation.

TM-ID: 000047144 - 003

10 – SS T-Coolant Intercooler (Limit 2)

ZKP-Number: 2.0124.932

Yellow alarm; power limitation < 20%;

Cause	Corrective action
Coolant temperature in intercooler too high.	<ol style="list-style-type: none">1. Reduce power.2. Check engine lines for leaks. Check coolant cooler for leaks, contamination and operation.3. Contact Service.

15 – LO P-Lube Oil

ZKP-Number: 2.0100.921

Yellow alarm; warning

Cause	Corrective action
Lube oil pressure too low.	► Check oil level, top up as necessary (→ Page 97).

16 – SS P-Lube Oil (Limit 2)

ZKP-Number: 2.0100.922

Red alarm; engine stop

Cause	Corrective action
Lube oil pressure too low.	<ol style="list-style-type: none">1. Check oil level, top up as necessary (→ Page 97).2. Acknowledge alarm.3. Restart engine (→ Page 29).4. Request towing locomotive if required.

19 – HI T-Exhaust A

ZKP-Number: 2.0126.931

Yellow alarm; warning

Cause	Corrective action
Exhaust gas temperature (A-side) too high.	<ol style="list-style-type: none">1. Reduce power.2. Check air filter.3. Request towing locomotive if required.

20 – SS T-Exhaust A

ZKP-Number: 2.0126.932

Red alarm; power reduction ≥ 20%

Cause	Corrective action
Exhaust gas temperature (A-side) too high.	<ol style="list-style-type: none">1. Reduce power.2. Check air filter.3. Request towing locomotive if required.

21 – HI T-Exhaust B

ZKP-Number: 2.0127.931

Yellow alarm; warning

Cause	Corrective action
Exhaust gas temperature (B-side) too high.	1. Reduce power. 2. Check air filter. 3. Request towing locomotive if required.

22 – SS T-Exhaust B

ZKP-Number: 2.0127.932

Red alarm; power reduction $\geq 20\%$

Cause	Corrective action
Exhaust gas temperature (B-side) too high.	1. Reduce power. 2. Check air filter. 3. Request towing locomotive if required.

25 – HI P-Diff-Lube Oil

ZKP-Number: 2.0154.931

Yellow alarm; warning

Cause	Corrective action
Differential pressure at oil filter too high.	► Replace oil filter (→ Page 99).

26 – SS P-Diff-Lube Oil

ZKP-Number: 2.0154.932

Red alarm; power reduction $\geq 20\%$

Cause	Corrective action
Differential pressure at oil filter too high.	1. Replace oil filter (→ Page 99). 2. Request towing locomotive if required.

30 – SS Engine Overspeed (Limit 2)

ZKP-Number: 2.2510.932

Red alarm; engine stop

Cause	Corrective action
Engine speed too high.	1. Acknowledge alarm. 2. Request towing locomotive if required.

TM-ID: 000047144 - 003

31 – HI ETC1 Overspeed (Limit 1)

ZKP-Number: 2.3011.931

Yellow alarm; power limitation > 20%

Cause	Corrective action
ETC 1 (A-side) speed too high.	<ol style="list-style-type: none">1. Reduce power.2. Check air filter.3. Check exhaust pipe visually for leaks.4. Request towing locomotive if required.

32 – SS ETC1 Overspeed (Limit 2)

ZKP-Number: 2.3012.932

Red alarm; power reduction \geq 20%

Cause	Corrective action
ETC 1 (A-side) speed too high.	<ol style="list-style-type: none">1. Reduce power.2. Check air filter.3. Check exhaust pipe visually for leaks.4. Request towing locomotive if required.

33 – Hi P-Diff-Fuel

ZKP-Number: 2.0114.931

Yellow alarm; warning

Cause	Corrective action
Differential pressure on fuel filter too high.	► Check fuel filter, replace if necessary.

34 – SS P-Diff-Fuel

ZKP-Number: 2.0114.932

No alarm, fault is entered

Cause	Corrective action
Differential pressure on fuel filter too high.	► Check fuel filter, replace if necessary.

36 – HI ETC2 Overspeed (Limit 1)

ZKP-Number: 2.3013.931

Yellow alarm; power limitation > 20%

Cause	Corrective action
ETC 2 (B-side) speed too high.	<ol style="list-style-type: none">1. Reduce power.2. Check air filter.3. Check exhaust pipe visually for leaks.4. Request towing locomotive if required.

37 – SS ETC2 Overspeed (Limit 2)

ZKP-Number: 2.3013.912

Red alarm; power reduction $\geq 20\%$

Cause	Corrective action
ETC 2 (B-side) speed too high.	<ol style="list-style-type: none">1. Reduce power.2. Check air filter.3. Check exhaust pipe visually for leaks.4. Request towing locomotive if required.

51 – HI T-Lube Oil

ZKP-Number: 2.0125.931

Yellow alarm; warning

Cause	Corrective action
Lube oil temperature too high.	<ol style="list-style-type: none">1. Reduce power.2. If fault code number 67 is signaled at the same time, then it has priority.

52 – SS T-Lube Oil (Limit 2)

ZKP-Number: 2.0125.932

Red alarm; power reduction $\geq 20\%$

Cause	Corrective action
Lube oil temperature too high.	<ol style="list-style-type: none">1. Reduce power.2. If fault code number 67 is signaled at the same time, then it has priority.

59 – SS T-Coolant (Limit 3)

ZKP-Number: 2.0120.933

Red alarm; forced idle

Cause	Corrective action
Coolant temperature too high.	<ol style="list-style-type: none">1. Activate fan emergency operating mode if required.2. Allow engine to cool down.3. Check engine coolant cooler, clean if dirty.4. Acknowledge alarm.5. Restart engine (→ Page 29).6. Request towing locomotive if required.

TIM-ID: 0000047144 - 003

60 – SS T-Coolant (Limit 4)

ZKP-Number: 2.0120.934

Red alarm; engine stop

Cause	Corrective action
Coolant temperature too high.	<ol style="list-style-type: none">1. Allow engine to cool down.2. Check engine coolant cooler, clean if dirty.3. Acknowledge alarm.4. Restart engine (→ Page 29).5. Activate fan emergency operating mode if required.6. Request towing locomotive if required.

63 – HI P-Crank Case

ZKP-Number: 2.0106.931

Red alarm; engine stop

Cause	Corrective action
Crankcase pressure too high.	<ol style="list-style-type: none">1. Contact Service.2. Request towing locomotive if required.

64 – SS P-Crank Case (Limit 2)

ZKP-Number: 2.0106.932

Red alarm; engine stop

Cause	Corrective action
Crankcase pressure too high.	<ol style="list-style-type: none">1. Contact Service.2. Request towing locomotive if required.

65 – LO P-Fuel

ZKP-Number: 2.0102.921

Yellow alarm; warning

Cause	Corrective action
Fuel pressure before HP pump too low.	<ol style="list-style-type: none">1. Check fuel lines for leakage.2. Drain fuel prefilter (→ Page 91).3. Replace filter element of fuel prefilter (→ Page 92).4. Replace fuel filter (→ Page 89).

66 – SS P-Fuel (Low) (Limit 2)

ZKP-Number: 2.0102.922

No alarm, fault is entered

Cause	Corrective action
Fuel pressure before HP pump too low. Possibly only reduced power is available.	<ol style="list-style-type: none">1. Check fuel lines for leakage.2. Drain fuel prefilter (→ Page 91).3. Replace filter element of fuel prefilter (→ Page 92).4. Replace fuel filter (→ Page 89).

67 – HI T-Coolant (Limit 1)

ZKP-Number: 2.0120.931

Yellow alarm; warning

Cause	Corrective action
Coolant temperature too high.	1. Reduce power. 2. Check engine coolant cooler, clean if dirty.

68 – SS T-Coolant (Limit 2)

ZKP-Number: 2.0120.932

Yellow alarm; power limitation < 20%;

Cause	Corrective action
Coolant temperature too high.	1. Activate fan emergency operating mode if required. 2. Allow engine to cool down. 3. Check engine coolant cooler, clean if dirty.

82 – HI P-Fuel (Common Rail) (Limit 1) (in ADEC L2)

ZKP-Number: 2.0104.931

Red alarm; power reduction \geq 20%

Cause	Corrective action
Rail pressure > set value; DBR fuel limitation; start of injection readjusted (retarded); HP fuel control block jamming or wiring faulty.	► Contact Service.

83 – LO P-Fuel (Common Rail) (Limit 1)

ZKP-Number: 2.0104.921

Red alarm; power reduction \geq 20%

Cause	Corrective action
Rail pressure < set value; DBR fuel limitation; HP fuel control block faulty or leakage in HP fuel system.	1. Request towing locomotive if required. 2. Contact Service.

89 – AL Engine Speed Low (Stall < ~200 RPM)

ZKP-Number: 2.2500.030

Red alarm; engine stop

Cause	Corrective action
Engine speed too low.	1. Acknowledge alarm. 2. Restart engine (→ Page 29). 3. Observe additional messages. 4. Request towing locomotive if required.

TM-ID: 000047144 - 003

90 – SS Idle Speed Not Reached

ZKP-Number: 2.1090.925

Yellow alarm; warning

Cause	Corrective action
Idle speed not reached.	<ol style="list-style-type: none">1. Check battery.2. Check wiring and voltage supply.3. Initiate new starting attempt.4. Request towing locomotive if required.

91 – SS Release (Run up)Speed Not Reached (< ~300 RPM)

ZKP-Number: 2.1090.924

Yellow alarm; warning

Cause	Corrective action
Runup speed not reached.	<ol style="list-style-type: none">1. Check battery.2. Check starter.3. Initiate new starting attempt.4. Request towing locomotive if required.

92 – SS Starter Speed Not Reached

ZKP-Number: 2.1090.923

Yellow alarm; warning

Cause	Corrective action
Starter speed not reached; termination of starting sequence; starter does not turn or turns slowly.	<ol style="list-style-type: none">1. Initiate new starting attempt.2. Check voltage at starter power supply.3. Request towing locomotive if required.

93 – SS T-Preheat

ZKP-Number: 2.1090.922

No alarm, fault is entered

Cause	Corrective action
Preheating temperature too low; coolant temperature too low for engine start. Significantly increased engine wear. Engine start might be inhibited by the locomotive control system. Engine may be started in emergency situations only.	<ol style="list-style-type: none">1. Extend preheating period.2. Check preheating unit.

94 – LO T-Preheat

ZKP-Number: 2.1090.921

Yellow alarm; warning

Cause	Corrective action
Preheating temperature too low; coolant temperature too low for engine start. Excessive engine wear. Engine start might be inhibited by the locomotive control system. Engine may be started in emergency situations only.	1. Extend preheating period. 2. Check preheating unit.

102 – AL Fuel Cons. Counter Defect

ZKP-Number: 1.8004.624

Yellow alarm; warning

Cause	Corrective action
Consumption meter faulty.	► Replace consumption meter.

104 – AL Eng Hours Counter Defect

ZKP-Number: 1.8004.623

Yellow alarm; warning

Cause	Corrective action
Hour meter faulty.	► Replace hour meter.

118 – LO ECU Power Supply Voltage

ZKP-Number: 2.0140.921

Yellow alarm; warning

Cause	Corrective action
Supply voltage too low.	► Check engine governor supply voltage.

119 – LOLO ECU Power Supply Voltage (Limit 2)

ZKP-Number: 2.0140.922

Red alarm; engine stop

Cause	Corrective action
Supply voltage too low.	1. Check engine governor supply voltage. 2. Acknowledge alarm. 3. Restart engine (→ Page 29). 4. Request towing locomotive if required.

T1M-ID: 0000047144 - 003

120 – HI ECU Power Supply Voltage

ZKP-Number: 2.0140.931

Yellow alarm; warning

Cause	Corrective action
Supply voltage too high.	► Check engine governor supply voltage.

121 – HIHI ECU Power Supply Voltage (Limit 2)

ZKP-Number: 2.0140.932

Red alarm; engine stop

Cause	Corrective action
Supply voltage too high.	<ol style="list-style-type: none">1. Check engine governor supply voltage.2. Acknowledge alarm.3. Restart engine (→ Page 29).4. Request towing locomotive if required.

122 – HI T-ECU

ZKP-Number: 2.0132.921

Yellow alarm; warning

Cause	Corrective action
Electronic unit temperature too high.	<ol style="list-style-type: none">1. Reduce power.2. Observe subsequent fault messages, e.g. intercooler.

180 – AL CAN1 Node Lost

ZKP-Number: 2.0500.680

Yellow alarm; warning

Cause	Corrective action
Connection to a node on CAN bus 1 failed.	<ol style="list-style-type: none">1. Check devices connected to CAN.2. Check wiring (2x12 1Ω terminating resistor available?).3. Contact Service.

181 – AL CAN2 Node Lost

ZKP-Number: 2.0500.681

Yellow alarm; warning

Cause	Corrective action
Connection to a node on CAN bus 2 failed.	<ol style="list-style-type: none">1. Check devices connected to CAN.2. Check wiring (2x12 1Ω terminating resistor available?).3. Contact Service.

182 – AL CAN Wrong Parameters

ZKP-Number: 2.0500.682

Yellow alarm; warning

Cause	Corrective action
Incorrect parameter values entered in data record.	► Contact Service.

183 – AL CAN No PU-Data

ZKP-Number: 2.0500.683

Yellow alarm; warning

Cause	Corrective action
The selected CAN mode initializes communication by means of the PU data module. However, the required PU data module is not available or not valid.	1. Check devices connected to CAN. 2. Contact Service.

184 – AL CAN PU-Data Flash Error

ZKP-Number: 2.0500.684

Yellow alarm; warning

Cause	Corrective action
A programming error occurred when attempting to copy a received PU data module into the Flash module.	► Contact Electronics Service.

186 – AL CAN1 Bus Off

ZKP-Number: 2.0500.686

Yellow alarm; warning

Cause	Corrective action
CAN controller 1 is in "Bus-Off" status.	1. Check CAN bus for short circuit, rectify short circuit as necessary. 2. Check shielding, improve shielding as necessary.

187 – AL CAN1 Error Passive

ZKP-Number: 2.0500.687

Yellow alarm; warning

Cause	Corrective action
CAN controller 1 has signaled a warning.	1. Check CAN bus for short circuit, rectify short circuit as necessary. 2. Check shielding, improve shielding as necessary.

TIM-ID: 0000047144 - 003

188 – AL CAN2 Bus Off

ZKP-Number: 2.0500.688

Yellow alarm; warning

Cause	Corrective action
CAN controller 2 is in "Bus-Off" status. Automatic changeover to CAN 1; short circuit; massive interference or baud rate incompatibility.	<ol style="list-style-type: none">1. Check CAN bus for short circuit, rectify short circuit as necessary.2. Check shielding, improve shielding as necessary.

189 – AL CAN2 Error Passive

ZKP-Number: 2.0500.689

Yellow alarm; warning

Cause	Corrective action
CAN controller 2 has signaled a warning.	<ol style="list-style-type: none">1. Check CAN bus for short circuit, rectify short circuit as necessary.2. Check shielding, improve shielding as necessary.

201 – SD T-Coolant

ZKP-Number: 1.8004.570

Yellow alarm; power limitation < 20%;

Cause	Corrective action
Coolant temperature sensor faulty; short circuit or wire break.	► Check sensors B6.1, B6.3, and cabling , replace if necessary (→ Page 119).

203 – SD T-Charge Air

ZKP-Number: 1.8004.571

Yellow alarm; power limitation < 20%;

Cause	Corrective action
Charge-air temperature sensor faulty; short circuit or wire break.	► Check sensors B9.1, B9.2, B9.3, and cabling , replace if necessary (→ Page 119).

204 – SD Level Lube Oil

ZKP-Number: 1.8004.602

Optional yellow alarm; warning

Cause	Corrective action
Lube oil level sensor faulty; short circuit or wire break.	► Check sensor B93 and wiring, replace as necessary (→ Page 119).

205 – SD T-Coolant Intercooler

ZKP-Number: 1.8004.574

Yellow alarm; warning

Cause	Corrective action
Intercooler coolant temperature sensor faulty; short circuit or wire break.	► Check sensor B26 and wiring, replace as necessary (→ Page 119).

206 – SD T-Exhaust A

ZKP-Number: 1.8004.576

Yellow alarm; warning

Cause	Corrective action
Exhaust temperature sensor on A-side faulty; short circuit or wire break.	► Check sensor B4.21 and wiring, replace as necessary (→ Page 119).

207 – SD T-Exhaust B

ZKP-Number: 1.8004.577

Yellow alarm; warning

Cause	Corrective action
Exhaust temperature sensor on B-side faulty; short circuit or wire break.	► Check sensor B4.22 and wiring, replace as necessary (→ Page 119).

208 – SD P-Charge Air

ZKP-Number: 1.8004.566

Yellow alarm; power limitation < 20%;

Cause	Corrective action
Charge-air pressure sensor faulty; short circuit or wire break.	► Check sensor B10 and wiring, replace as necessary (→ Page 119).

211 – SD P-Lube Oil

ZKP-Number: 1.8004.563

Yellow alarm; power limitation < 20%;

Cause	Corrective action
Lube oil pressure sensor faulty; short circuit or wire break.	► Check sensors B5.1, B5.3, and cabling , replace if necessary (→ Page 119).

TTM-ID: 0000047144 - 003

214 – SD P-CrankCase

ZKP-Number: 1.8004.568

Yellow alarm; warning

Cause	Corrective action
Crankcase pressure sensor faulty; short circuit or wire break.	► Check sensor B50 and wiring, replace as necessary (→ Page 119).

215 – SD P-HD High Pressure Fuel

ZKP-Number: 1.8004.567

Yellow alarm; power limitation < 20%;

Cause	Corrective action
Rail pressure sensor faulty; high-pressure regulator emergency mode; short circuit or wire break.	► Check sensors B48.1, B48.2, and cabling , replace if necessary (→ Page 119).

216 – SD T-Lube Oil

ZKP-Number: 1.8004.575

Yellow alarm; warning

Cause	Corrective action
Lube oil temperature sensor faulty; short circuit or wire break.	► Check sensor B7 and wiring, replace as necessary (→ Page 119).

219 – SD T-Intake Air

ZKP-Number: 1.8004.573

Yellow alarm; warning

Cause	Corrective action
Intake air temperature sensor faulty; short circuit or wire break.	► Check sensor B90 and wiring, replace as necessary (→ Page 119).

221 – SD Dif Lube Oil

ZKP-Number: 1.8004.585

Yellow alarm; warning

Cause	Corrective action
Lube oil pressure differential sensor faulty; short circuit or wire break.	► Check sensor B93 and wiring, replace as necessary (→ Page 119).

227 – SD P-Lube Oil before Filter

ZKP-Number: 1.8004.620

Yellow alarm; warning

Cause	Corrective action
Sensor for lube oil pressure before filter faulty; short circuit or wire break.	► Check sensor B5.3 and wiring, replace as necessary (→ Page 119).

228 – SD P-Fuel before Filter

ZKP-Number: 1.8004.595

Yellow alarm; warning

Cause	Corrective action
Fuel pressure sensor faulty; short circuit or wire break.	► Check sensor B34.2 and wiring, replace as necessary (→ Page 119).

229 – AL Stop Camshaft and Crankshaft Sensor Defect

ZKP-Number: 1.8004.562

Red alarm; engine stop

Cause	Corrective action
Engine stop due to camshaft sensor fault and a previous crankshaft sensor fault in the same operating cycle.	<ol style="list-style-type: none">1. Check sensor and wiring to connectors B1 and B13, replace as necessary (→ Page 119).2. Acknowledge alarm.3. Restart engine (→ Page 29).

230 – SD Crankshaft Speed

ZKP-Number: 1.8004.498

Yellow alarm; power limitation < 20%;

Cause	Corrective action
Crankshaft sensor faulty; short circuit or wire break.	► Check sensor B13 and wiring, replace as necessary (→ Page 119).

231 – SD Camshaft Speed

ZKP-Number: 1.8004.499

Yellow alarm; warning

Cause	Corrective action
Camshaft sensor faulty; short circuit or wire break.	► Check sensor B1 and wiring, replace as necessary (→ Page 119).

TIM-ID: 0000047144-003

232 – SD Charger 1 Speed

ZKP-Number: 1.3011.128

Yellow alarm; warning

Cause	Corrective action
Speed sensor of primary turbocharger faulty; short circuit or wire break.	► Check sensor B44.1 and wiring, replace as necessary (→ Page 119).

233 – SD Charger 2 Speed

ZKP-Number: 1.3011.129

Yellow alarm; warning

Cause	Corrective action
Speed sensor of primary turbocharger faulty; short circuit or wire break.	► Check sensor B44.2 and wiring, replace as necessary (→ Page 119).

239 – SD P-Diff Fuel

ZKP-Number: 1.8004.598

Yellow alarm; warning

Cause	Corrective action
Pressure sensors for differential fuel pressure faulty; short circuit or wire break. Fault only occurs in connection.	► Check sensors B34.1, B34.2, and cabling , replace if necessary (→ Page 119).

240 – SD P-Fuel

ZKP-Number: 1.8004.565

Yellow alarm; warning

Cause	Corrective action
Fuel pressure sensor after fuel main filter defective; short circuit or wire break.	► Check sensors B34.1, B34.2, and cabling , replace if necessary (→ Page 119).

245 – SD ECU Power Supply Voltage

ZKP-Number: 2.8006.589

Yellow alarm; warning

Cause	Corrective action
Internal engine governor fault; electronics faulty.	► Replace engine governor.

266 – SD Speed Demand

ZKP-Number: 2.8006.586

Red alarm; forced idle

Cause	Corrective action
Analog nominal speed setting faulty; short circuit or wire break.	1. Check wiring (→ Page 119). 2. Check speed setting. 3. Contact Service.

270 – SD Frequency Input

ZKP-Number: 2.8006.590

Red alarm; forced idle

Cause	Corrective action
Frequency input faulty; short circuit or wire break.	1. Check wiring (→ Page 119). 2. Check setpoint speed transmitter. 3. Contact Service.

321 – AL Wiring Cylinder A1

ZKP-Number: 1.8004.520

Yellow alarm; warning

Cause	Corrective action
Short circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

322 – AL Wiring Cylinder A2

ZKP-Number: 1.8004.521

Yellow alarm; warning

Cause	Corrective action
Short circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

323 – AL Wiring Cylinder A3

ZKP-Number: 1.8004.522

Yellow alarm; warning

Cause	Corrective action
Short circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

TIM-ID: 0000047144 - 003

324 – AL Wiring Cylinder A4

ZKP-Number: 1.8004.523

Yellow alarm; warning

Cause	Corrective action
Short circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

325 – AL Wiring Cylinder A5

ZKP-Number: 1.8004.524

Yellow alarm; warning

Cause	Corrective action
Short circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

326 – AL Wiring Cylinder A6

ZKP-Number: 1.8004.525

Yellow alarm; warning

Cause	Corrective action
Short circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

331 – AL Wiring Cylinder B1

ZKP-Number: 1.8004.530

Yellow alarm; warning

Cause	Corrective action
Short circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

332 – AL Wiring Cylinder B2

ZKP-Number: 1.8004.531

Yellow alarm; warning

Cause	Corrective action
Short circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

333 – AL Wiring Cylinder B3

ZKP-Number: 1.8004.532

Yellow alarm; warning

Cause	Corrective action
Short circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

334 – AL Wiring Cylinder B4

ZKP-Number: 1.8004.533

Yellow alarm; warning

Cause	Corrective action
Short circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

335 – AL Wiring Cylinder B5

ZKP-Number: 1.8004.534

Yellow alarm; warning

Cause	Corrective action
Short circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

336 – AL Wiring Cylinder B6

ZKP-Number: 1.8004.535

Yellow alarm; warning

Cause	Corrective action
Short circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

341 – AL Open Load Cylinder A1

ZKP-Number: 1.8004.540

Yellow alarm; warning

Cause	Corrective action
Open circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

342 – AL Open Load Cylinder A2

ZKP-Number: 1.8004.541

Yellow alarm; warning

Cause	Corrective action
Open circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

343 – AL Open Load Cylinder A3

ZKP-Number: 1.8004.542

Yellow alarm; warning

Cause	Corrective action
Open circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

TIM-ID: 0000047144 - 003

344 – AL Open Load Cylinder A4

ZKP-Number: 1.8004.543

Yellow alarm; warning

Cause	Corrective action
Open circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

345 – AL Open Load Cylinder A5

ZKP-Number: 1.8004.544

Yellow alarm; warning

Cause	Corrective action
Open circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

346 – AL Open Load Cylinder A6

ZKP-Number: 1.8004.545

Yellow alarm; warning

Cause	Corrective action
Open circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

351 – AL Open Load Cylinder B1

ZKP-Number: 1.8004.550

Yellow alarm; warning

Cause	Corrective action
Open circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

352 – AL Open Load Cylinder B2

ZKP-Number: 1.8004.551

Yellow alarm; warning

Cause	Corrective action
Open circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

353 – AL Open Load Cylinder B3

ZKP-Number: 1.8004.552

Yellow alarm; warning

Cause	Corrective action
Open circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

354 – AL Open Load Cylinder B4

ZKP-Number: 1.8004.553

Yellow alarm; warning

Cause	Corrective action
Open circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

355 – AL Open Load Cylinder B5

ZKP-Number: 1.8004.554

Yellow alarm; warning

Cause	Corrective action
Open circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

356 – AL Open Load Cylinder B6

ZKP-Number: 1.8004.555

Yellow alarm; warning

Cause	Corrective action
Open circuit in cylinder injector wiring. Result: Misfiring.	► Check solenoid valve.

361 – AL Power Stage Low (Internal Electronic Failure)

ZKP-Number: 1.8004.496

Red alarm; engine stop

Cause	Corrective action
Internal electronic fault, electronics possibly faulty.	<ol style="list-style-type: none">1. Observe any other messages.2. Check solenoid valve wiring (→ Page 119).3. Acknowledge alarm.4. Restart engine (→ Page 29).5. Request towing locomotive if required.

362 – AL Power Stage High (Internal Electronic Failure)

ZKP-Number: 1.8004.497

Red alarm; engine stop

Cause	Corrective action
Internal electronic fault, electronics possibly faulty.	<ol style="list-style-type: none">1. Observe any other messages.2. Check solenoid valve wiring (→ Page 119).3. Acknowledge alarm.4. Restart engine (→ Page 29).5. Request towing locomotive if required.

TIM-ID: 0000047144 - 003

363 – AL Stop Power Stage

ZKP-Number: 1.8004.560

Red alarm; engine stop

Cause	Corrective action
Internal electronic fault, electronics possibly faulty.	<ol style="list-style-type: none">1. Check wiring (→ Page 119).2. Acknowledge alarm.3. Restart engine.4. Request towing locomotive if required.

365 – AL Stop MV-Wiring Ground (Injector Amplifier Ground)

ZKP-Number: 1.8004.561

Red alarm; engine stop

Cause	Corrective action
Injector wiring fault.	<ol style="list-style-type: none">1. Check wiring (→ Page 119).2. Acknowledge alarm.3. Restart engine.4. Request towing locomotive if required.

381 – AL Wiring TOP 1

ZKP-Number: 2.8006.638

Yellow alarm; warning

Cause	Corrective action
Short circuit or wire break on transistor output 1 plant-side 1 (TOP 1).	► Check wiring to plant (→ Page 119).

382 – AL Wiring TOP 2

ZKP-Number: 2.8006.639

Yellow alarm; warning

Cause	Corrective action
Short circuit or wire break on transistor output 2 plant-side (TOP 2).	► Check wiring to plant (→ Page 119).

383 – AL Wiring TOP 3

ZKP-Number: 2.8006.640

Yellow alarm; warning

Cause	Corrective action
Short circuit or wire break on transistor output 3 plant-side (TOP 3).	► Check wiring to plant (→ Page 119).

384 – AL Wiring TOP 4

ZKP-Number: 2.8006.641

Yellow alarm; warning

Cause	Corrective action
Short circuit or wire break on transistor output 4 plant-side (TOP 4).	► Check wiring to plant (→ Page 119).

408 – AL Open Load Emerg. Stop Input ESI

ZKP-Number: 2.8006.633

Yellow alarm; warning

Cause	Corrective action
Line disruption on the input for emergency stop; wiring defective or no resistance through the switch.	<ol style="list-style-type: none">1. Check wiring (→ Page 119).2. Check target device input.

410 – LO U-PDU (Low Injector Voltage) (Limit 1)

ZKP-Number: 2.0141.921

Yellow alarm; warning

Cause	Corrective action
Injector voltage too low.	<ol style="list-style-type: none">1. Check wiring (→ Page 119).2. Check supply.

411 – LOLO U-PDU (Injector Voltage) (Limit 2)

ZKP-Number: 2.0141.922

Red alarm; engine stop

Cause	Corrective action
Injector voltage too low.	<ol style="list-style-type: none">1. Check wiring (→ Page 119).2. Check supply.3. Acknowledge alarm.4. Restart engine.5. Request towing locomotive if required.

412 – HI U-PDU (High Injector Voltage) (Limit 1)

ZKP-Number: 2.0141.931

Yellow alarm; warning

Cause	Corrective action
Injector voltage too high.	<ol style="list-style-type: none">1. Check wiring (→ Page 119).2. Check supply.

TM-ID: 000047144 - 003

413 – HIHI U-PDU (Injector Voltage) (Limit 2

ZKP-Number: 2.0141.932

Red alarm; engine stop

Cause	Corrective action
Injector voltage too high.	<ol style="list-style-type: none">1. Check wiring (→ Page 119).2. Check supply.3. Acknowledge alarm.4. Restart engine.5. Request towing locomotive if required.

414 – HI Level Water Fuel Prefilter

ZKP-Number: 2.0156.931

Yellow alarm; warning

Cause	Corrective action
Water level in fuel prefilter too high.	► Empty fuel prefilter.

417 – SD Level Water Fuel Prefilter

ZKP-Number: 1.8004.594

Yellow alarm; warning

Cause	Corrective action
Water level sensor of fuel prefilter faulty, short circuit or wire break.	► Check sensor and wiring, replace as necessary.

422 – SD T-Charge Air B

ZKP-Number: 2.0130.605

Yellow alarm; warning

Cause	Corrective action
Charge-air temperature sensor faulty; short circuit or wire break.	► Check sensor B10.11 and wiring, replace as necessary (→ Page 119).

438 – LO P-Fuel 2 (Common Rail)

ZKP-Number: 2.0116.921

Red alarm; power reduction $\geq 20\%$

Cause	Corrective action
Rail pressure below desired value; DBR reduction. HP fuel control block faulty or leakage in HP fuel system.	► Contact Service.

439 – HI P-Fuel 2 (Common Rail)

ZKP-Number: 2.0116.931

Red alarm; power reduction $\geq 20\%$

Cause	Corrective action
Rail pressure above desired value; DBR reduction. HP fuel control block faulty, short circuit or wire break.	► Contact Service.

441 – AL Rail 2 Leakage

ZKP-Number: 1.8004.047

Yellow alarm; warning

Cause	Corrective action
Pressure gradient in rail is too low during starting or too high during stopping. HP system leaky, air in system.	► Contact Service.

444 – SD U-PDU (Injector Voltage)

ZKP-Number: 1.8004.578

Yellow alarm; warning

Cause	Corrective action
Injector power stage sensor defect; internal fault in engine governor.	► Replace engine governor.

446 – SD P-HD2

ZKP-Number: 1.8004.599

Yellow alarm; power limitation $< 20\%$;

Cause	Corrective action
Rail pressure sensor faulty, high-pressure regulator emergency mode; short circuit or wire break.	► Check sensor B48 and wiring, replace as necessary (→ Page 119).

450 – SD Idle/End-Torque Input [%]

ZKP-Number: 2.8006.592

Red alarm; forced idle

Cause	Corrective action
Input signal for initial/final torque faulty; short circuit or wire break.	1. Check signal transmitter and cabling, replace as necessary. 2. Restart engine (→ Page 29).

TTM-ID: 0000047144 - 003

454 – SS Power Reduction Active

ZKP-Number: 2.7000.011

CAN message

Cause	Corrective action
Alarm is only available as a separate CAN message, power reduction is active.	<ol style="list-style-type: none">1. Observe any other messages.2. Determine and rectify cause of power reduction.

467 – AL L2 T-Aux 1

ZKP-Number: 2.0130.922

Red alarm; engine stop

Cause	Corrective action
Temperature signal from Aux 1 violated limit value 2.	<ol style="list-style-type: none">1. Check wiring (→ Page 119).2. Acknowledge alarm.3. Restart engine.4. Request towing locomotive if required.

470 – SD T-ECU

ZKP-Number: 1.8004.587

Yellow alarm; warning

Cause	Corrective action
Temperature sensor for engine governor faulty; short circuit or wire break.	► Check sensor and wiring, replace as necessary (→ Page 119).

471 – SD Coil Current (High Pressure Pump suction valve)

ZKP-Number: 1.8004.592

Yellow alarm; warning

Cause	Corrective action
Control of HP fuel control block faulty; short circuit or wire break.	► Check sensor and wiring, replace as necessary (→ Page 119).

474 – AL Wiring FO

ZKP-Number: 2.8006.655

Yellow alarm; warning

Cause	Corrective action
Line break or short circuit at FO channel.	► Check wiring (→ Page 119).

476 – AL Crash Rec. Init. Error (Occurs when ADEC has power)

ZKP-Number: 1.8010.007

Yellow alarm; warning

Cause	Corrective action
Initialization error of crash recorder.	► Check setting with DiaSys.

478 – AL Comb. Alarm Yel (Plant)

ZKP-Number: 2.8006.001

Yellow alarm; warning

Cause	Corrective action
Combined alarm initiated by plant.	► Observe any other messages.

479 – AL Comb. Alarm Red (Plant)

ZKP-Number: 2.8006.002

Red alarm

Cause	Corrective action
Combined alarm initiated by plant.	► Observe any other messages.

500 – AL Wiring POM Starter 1

ZKP-Number: 1.4500.900

Yellow alarm; warning

Cause	Corrective action
A cabling fault in connection of starter 1 to POM has been detected. This may be due to a missing consumer, wire break or a short circuit.	► Check connection between POM and starter.

501 – AL Wiring POM Starter 2

ZKP-Number: 1.4500.901

Yellow alarm; warning

Cause	Corrective action
A cabling fault in connection of starter 2 to POM has been detected. This may be due to a missing consumer, wire break or a short circuit.	► Check connection between POM and starter.

TIM-ID: 0000047144 - 003

502 – AL Open Load POM Alternator

ZKP-Number: 1.4500.902

Yellow alarm; warning

Cause	Corrective action
A line interruption was detected at the battery-charging generator connection for the POM.	► Check connection between POM and battery-charging generator.

503 – AL Battery Not Charging

ZKP-Number: 1.4500.903

Yellow alarm; warning

Cause	Corrective action
Battery is not charged by battery-charging generator.	► Check battery-charging generator and wiring (→ Page 119).

504 – AL CAN POM Node Lost

ZKP-Number: 1.4500.904

Yellow alarm; warning

Cause	Corrective action
POM missing on CAN bus.	► Check connection and POM.

506 – AL Low Starter Voltage

ZKP-Number: 1.4500.906

Yellow alarm; warning

Cause	Corrective action
The battery voltage is too low for the starting process.	► Check starter battery and wiring (→ Page 119).

507 – AL POM Error

ZKP-Number: 1.4500.907

Yellow alarm; warning

Cause	Corrective action
A general POM fault occurred.	► Replace POM.

508 – AL Wrong POM-ID

ZKP-Number: 1.4500.908

Yellow alarm; warning

Cause	Corrective action
POM sends a different ID number than expected.	► Check POM wiring harness.

510 – AL Override applied

ZKP-Number: 2.7002.010

No alarm, fault is entered

Cause	Corrective action
Override Acknowledged	► Deactivate Override.

515 – AL Starter Not Engaged

ZKP-Number: 2.1090.926

Yellow alarm; warning

Cause	Corrective action
Starter on POM could not be engaged. If the number of admissible automatic starting attempts is executed, the starting sequence is terminated.	<ol style="list-style-type: none">1. Repeat start.2. Check POM, starter and wiring (→ Page 119).

519 – Oillevel Calibration Error (optional)

ZKP-Number: 1.0158.921

Yellow alarm; warning

Cause	Corrective action
Error writing calibration value into flash or SD of level sensor.	► Check sensor and wiring, replace as necessary (→ Page 119).

536 – AL Wiring PWM_CM1

ZKP-Number: 1.1041.921

Yellow alarm; warning

Cause	Corrective action
Wire break or short circuit on channel PWM_CM1.	► Check wiring to connected device or check connected device (actuator/sensor), replace if necessary.

549 – AL Power Cut-Off detected

ZKP-Number: 2.7001.952

Yellow alarm; warning

Cause	Corrective action
The operating voltage of the engine governor was switched off with the engine running. This may lead to overpressure in the HP fuel system, which might cause damage to the engine.	► Instruct the operator only to disconnect the power supply when the engine has stopped.

TIM-ID: 0000047144 - 003

551 – SS Engine Overspeed Camshaft

ZKP-Number: 2.2510.933

Red alarm; engine stop

Cause	Corrective action
Engine overspeed - camshaft	<ol style="list-style-type: none">1. Acknowledge alarm.2. Restart engine (→ Page 29).3. Request towing locomotive if required.

558 – AL Wiring PWM_CM2

ZKP-Number: 1.1041.922

Yellow alarm; warning

Cause	Corrective action
Wire break or short circuit on channel PWM_CM2.	► Check wiring to connected device or check connected device (actuator/sensor), replace if necessary.

593 – AL T-Lube Oil Pan Low (Option)

ZKP-Number: 2.1090.929

Yellow alarm; warning

Cause	Corrective action
T-Lube Oil Pan has violated the limit value (too cold); significantly increased engine wear. Engine start might be inhibited by the locomotive control system.	<ol style="list-style-type: none">1. Extend preheating period.2. Request towing locomotive if required.3. Move locomotive into heated hall if necessary.

594 – AL L1 UDV Defekt Rail 1

ZKP-Number: 1.1301.900

Yellow alarm; warning

Cause	Corrective action
Pressure relief valve of first rail faulty.	► Check pressure relief valve, replace as necessary.

595 – AL L2 UDV Defekt Rail 1

ZKP-Number: 1.1301.901

No alarm, fault is entered

Cause	Corrective action
Pressure relief valve of first rail faulty.	► Check pressure relief valve, replace as necessary.

596 – AL Develop PR Set

ZKP-Number: 1.8004.645

Yellow alarm; warning

Cause	Corrective action
Standard production data record available. The data record stored is for testing.	► Contact Service.

598 – AL L1 UDV Defekt Rail 2

ZKP-Number: 1.1302.900

Yellow alarm; warning

Cause	Corrective action
Pressure relief valve of second rail faulty.	► Check pressure relief valve, replace as necessary.

599 – AL L2 UDV Defekt Rail 2

ZKP-Number: 1.1302.901

No alarm, fault is entered

Cause	Corrective action
Pressure relief valve of second rail faulty.	► Check pressure relief valve, replace as necessary.

600 – SD T-Exhaust A+B

ZKP-Number: 1.8004.646

Red alarm; power reduction $\geq 20\%$

Cause	Corrective action
Exhaust temperature sensor on A and B sides defective; short circuit or wire break.	► Check sensors B4.21, B4.22, and cabling, replace if necessary.

602 – AL CAN Engine Start Lock

ZKP-Number: 2.1090.930

Yellow alarm; warning

Cause	Corrective action
Start interlock initiated by plant.	1. Check plant configuration. 2. Restart engine (→ Page 29). 3. Request towing locomotive if required.

TTM-ID: 0000047144 - 003

606 – AL Double Nodes Lost CAN 1+2

ZKP-Number: 2.0500.691

Red alarm; forced idle

Cause	Corrective action
No communication between ADEC and PAU.	1. Check wiring and power supply of plant. 2. Acknowledge alarm. 3. Restart engine (→ Page 29). 4. Request towing locomotive if required.

608 – AL Wiring PWM_CM6

ZKP-Number: 1.1041.926

No alarm, fault is entered

Cause	Corrective action
Wire break or short circuit on channel PWM_CM6.	► Check wiring to connected device or check connected device (actuator/sensor), replace if necessary.

609 – AL Wiring PWM_CM7

ZKP-Number: 1.1041.927

Yellow alarm; warning

Cause	Corrective action
Wire break or short circuit on channel PWM_CM7.	► Check wiring to connected device or check connected device (actuator/sensor), replace if necessary.

626 – AL Wiring PWM_CM8

ZKP-Number: 1.1041.928

No alarm, fault is entered

Cause	Corrective action
Wire break or short circuit on channel PWM_CM8.	► Check wiring to connected device or check connected device (actuator/sensor), replace if necessary.

627 – AL Wiring PWM_CM9

ZKP-Number: 1.1041.929

No alarm, fault is entered

Cause	Corrective action
Wire break or short circuit on channel PWM_CM9.	► Check wiring to connected device or check connected device (actuator/sensor), replace if necessary.

628 – AL Wiring PWM_CM10

ZKP-Number: 1.1041.930

Yellow alarm; warning

Cause	Corrective action
Wire break or short circuit on channel PWM_CM10.	► Check wiring to connected device or check connected device (actuator/sensor), replace if necessary.

629 – AL AGR Throttle A Defect

ZKP-Number: 1.0700.011

Yellow alarm; warning

Cause	Corrective action
Actuator at EGR shutoff flap A or flap mechanism faulty.	► Replace actuator or flap.

630 – AL AGR Throttle B Defect

ZKP-Number: 1.0700.031

Yellow alarm; warning

Cause	Corrective action
Actuator at EGR shutoff flap B or flap mechanism faulty.	► Replace actuator or flap.

631 – AL Bypass Throttle Defect

ZKP-Number: 1.0700.051

Yellow alarm; warning

Cause	Corrective action
Actuator at bypass flap or flap mechanism faulty.	► Replace actuator or flap.

633 – SD P-Ambient Air (HDT2800)

ZKP-Number: 1.0700.087

Yellow alarm; warning

Cause	Corrective action
Humirel HDT2800 CAN sensor faulty; short circuit or wire break.	► Check sensor B90 and wiring, replace as necessary.

TIM-ID: 0000047144 - 003

634 – SD T0-Ambient Air (HDT2800)

ZKP-Number: 1.0700.089

Yellow alarm; warning

Cause	Corrective action
T0 ambient air HDT2800 CAN temperature sensor faulty; short circuit or wire break.	► Check sensor B90 and wiring, replace as necessary.

635 – SD Air Humidity (HDT2800)

ZKP-Number: 1.0700.091

Yellow alarm; warning

Cause	Corrective action
Air humidity CAN sensor faulty; short circuit or wire break.	► Check sensor B90 and wiring, replace as necessary.

636 – SD Level Lube Oil J1939

ZKP-Number: 1.0700.105

Yellow alarm; warning

Cause	Corrective action
CAN lube oil level sensor faulty; short circuit or wire break.	► Check sensor and wiring, replace as necessary.

637 – SD T-Lube Oil Pan J1939

ZKP-Number: 1.0700.107

Yellow alarm; warning

Cause	Corrective action
Oil pan CAN temperature sensor faulty; short circuit or wire break.	► Check sensor and wiring, replace as necessary.

640 – SD Smart NOx Oxidation Factor O2

ZKP-Number: 1.0700.145

No alarm, fault is entered

Cause	Corrective action
Smart NOx sensor (oxidation factor O2) faulty; short circuit or wire break.	► Check sensors B88.1, B88.2, and cabling , replace if necessary.

647 – SD P-Exhaust Lambda

ZKP-Number: 1.0163.900

Yellow alarm; warning

Cause	Corrective action
Exhaust pressure sensor near lambda sensor faulty; short circuit or wire break.	1. Check sensor B91.3 and wiring, replace as necessary. 2. Restart engine (→ Page 29).

648 – SD P-Charge Air B

ZKP-Number: 1.0149.900

Yellow alarm; power limitation < 20%;

Cause	Corrective action
Charge-air pressure sensor on B-side faulty; short circuit or wire break.	1. Check sensor B10 and wiring, replace as necessary . 2. Restart engine (→ Page 29).

662 – SD Smart NOx Heater Element

ZKP-Number: 1.0700.141

Yellow alarm; warning

Cause	Corrective action
SD Smart NOx heating element faulty; short circuit or wire break.	► Check sensors B88.1, B88.2, and cabling , replace if necessary.

663 – SD Smart NOx Concentration

ZKP-Number: 1.0700.143

Yellow alarm; warning

Cause	Corrective action
Smart NOx sensor (NOx concentration) faulty; short circuit or wire break.	► Check sensors B88.1, B88.2, and cabling , replace if necessary.

727 – AL L1 Delta T-NT Intercooler

ZKP-Number: 2.1075.901

Yellow alarm; warning

Cause	Corrective action
T-Max. Coolant Intercooler Exceeded L1.	1. Reduce power. 2. Check intercooler and coolant cooler. 3. Check charge-air coolant circuit.

T/M-ID: 0000047144 - 003

728 – AL L2 Delta T-NT Intercooler

ZKP-Number: 2.1075.903

No alarm, fault is entered

Cause	Corrective action
T-Max. Coolant Intercooler Exceeded L2.	1. Reduce power. 2. Check intercooler and coolant cooler. 3. Check charge-air coolant circuit.

745 – AL Emission Fault

ZKP-Number: 2.1600.004

Red alarm; power reduction $\geq 20\%$

Cause	Corrective action
Emission fault.	1. Reduce power. 2. Check sensors and wiring.

754 – SD Bosch LSU Lambda Sensor

ZKP-Number: 1.0800.990

Yellow alarm; warning

Cause	Corrective action
Bosch LSU lambda sensor faulty.	► Check sensor and wiring, replace as necessary.

757 – AL Lim T-Coolant NT-Fan

ZKP-Number: 2.2800.900

Yellow alarm; warning

Cause	Corrective action
Charge-air cooler coolant has exceeded limit value.	1. Check coolant level, top up if necessary. 2. Check thermostat. 3. Check air filter.

796 – AL HI T-Charge Air B

ZKP-Number: 2.0146.931

Yellow alarm; warning

Cause	Corrective action
Charge-air temperature too high.	1. Reduce power. 2. If fault code number 9 is signaled at the same time, then it has priority.

797 – AL HIHI T-Charge Air B

ZKP-Number: 2.0146.932

Yellow alarm; power limitation < 20%;

Cause	Corrective action
Charge-air temperature too high.	1. Reduce power. 2. If fault code number 9 is signaled at the same time, then it has priority.

806 – SD Charger 3 Speed

ZKP-Number: 1.3010.901

Yellow alarm; warning

Cause	Corrective action
Speed sensor of secondary turbocharger faulty; short circuit or wire break.	► Check sensor B44.3 and wiring, replace as necessary (→ Page 119).

807 – SD Charger 4 Speed

ZKP-Number: 1.3010.903

Yellow alarm; warning

Cause	Corrective action
Speed sensor of secondary turbocharger faulty; short circuit or wire break.	► Check sensor B44.4 and wiring, replace as necessary (→ Page 119).

832 – AL EIL Different Engine Number

ZKP-Number: 1.0610.953

Yellow alarm; warning

Cause	Corrective action
EIL Different engine number	► Install the correct data set.

833 – AL Emission Warning

ZKP-Number: 2.1600.008

Yellow alarm; warning

Cause	Corrective action
Emission warning alarm.	1. Check flap control. 2. Check sensors.

TIM-ID: 0000047144 - 003

834 – AL Gas Path Warning

ZKP-Number: 2.1600.010

Yellow alarm; warning

Cause	Corrective action
Gas path warning alarm.	1. Check flap control. 2. Check sensors.

835 – AL Gas Path Fault

ZKP-Number: 2.1600.012

Red alarm; power reduction $\geq 20\%$

Cause	Corrective action
Gas path fault alarm.	1. Check flap control. 2. Check sensors.

843 – SD T-Charge Air before AGR

ZKP-Number: 1.0147.920

Yellow alarm; warning

Cause	Corrective action
Charge-air temperature sensor faulty; short circuit or wire break.	► Check sensor B9.1 and wiring, replace as necessary (→ Page 119).

844 – AL HI T-Charge Air before AGR

ZKP-Number: 2.0147.931

Yellow alarm; warning

Cause	Corrective action
Charge-air temperature too high.	► Reduce power.

845 – AL HIHI T-Charge Air before AGR

ZKP-Number: 2.0147.932

Red alarm; power limitation $\geq 20\%$; forced idle

Cause	Corrective action
Charge-air temperature too high.	1. Reduce power. 2. Acknowledge alarm. 3. Request towing locomotive if required.

851 – External Start and HD too high

ZKP-Number: 1.1026.901

Red alarm; power reduction $\geq 20\%$

Cause	Corrective action
Excessive pressure in HP fuel system when the engine is starting	► Stop engine. Restart. Repeat the process if necessary.

855 – AL Bypass Throttle 2 Defect

ZKP-Number: 1.0700.841

Yellow alarm; warning

Cause	Corrective action
Actuator at bypass flap or flap mechanism faulty.	► Replace actuator or flap.

872 – AL EGR A Fast learn failed

ZKP-Number: 1.0700.021

Yellow alarm; warning

Cause	Corrective action
Actuator at bypass flap or flap mechanism faulty.	► Replace actuator or flap.

876 – AL EGR B Fast learn failed

ZKP-Number: 1.0700.040

Yellow alarm; warning

Cause	Corrective action
Actuator at bypass flap or flap mechanism faulty.	► Replace actuator or flap.

877 – AL Bypass A Fast learn failed

ZKP-Number: 1.0700.060

Yellow alarm; warning

Cause	Corrective action
Actuator at bypass flap or flap mechanism faulty.	► Replace actuator or flap.

TIM-ID: 0000047144 - 003

878 – AL Bypass B Fast learn failed

ZKP-Number: 1.0700.851

Yellow alarm; warning

Cause	Corrective action
Actuator at bypass flap or flap mechanism faulty.	► Replace actuator or flap.

898 – AL Trican Communication Lost

ZKP-Number: 1.0700.099

Yellow alarm; warning

Cause	Corrective action
Wire break or sensor faulty.	1. Check cabling. 2. Replace sensor.

902 – HI T-Coolant Cylinder Head

ZKP-Number: 2.0054.002

Yellow alarm; warning

Cause	Corrective action
Cylinder head coolant temperature too high.	1. Check belt drive. 2. Check coolant pump.

903 – AL SD T Coolant at cylinder head

ZKP-Number: 1.0054.007

Yellow alarm; warning

Cause	Corrective action
Cylinder head coolant temperature sensor faulty.	1. Check cabling. 2. Replace sensor.

904 – SS T-Coolant Cylinder Head

ZKP-Number: 2.0054.004

Red alarm; power reduction $\geq 20\%$

Cause	Corrective action
Cylinder head coolant temperature too high.	1. Check belt drive. 2. Check coolant pump.

947 – AL Invalid LSI Channel Config

ZKP-Number: 1.0010.002

Yellow alarm; warning

Cause	Corrective action
Wrong parameterization of the engine governor.	► Contact Service.

953 – AL Lambda value invalid

ZKP-Number: 1.1600.903

Yellow alarm; warning

Cause	Corrective action
Invalid Lambda value.	<ol style="list-style-type: none">1. Check if coolant temperature (HT coolant circuit) is > 60 °C.2. If fault code number 754 is output at the same time, replace Lambda sensor.3. Contact Service.

954 – AL NOx value invalid

ZKP-Number: 1.1600.905

Yellow alarm; warning

Cause	Corrective action
Invalid NOx value.	<ol style="list-style-type: none">1. Check if coolant temperature (HT coolant circuit) is > 60 °C.2. If fault code number 663 is output at the same time, replace NOx sensor.3. Check condition of injectors.4. Check engine in steady-state condition for black exhaust color.5. Check if fault code 961 is active.6. Check engine for idle-speed hunting. Verify with DiaSys that the engine speed signal does not vary.7. Contact Service.

955 – AL Thermal Management active

ZKP-Number: 1.1600.907

Yellow alarm; warning

Cause	Corrective action
Engine is in NTE (Not-To-Exceed) range; Thermal management is active.	► Contact Service.

956 – AL p5 ctrlvar limit min active

ZKP-Number: 1.1600.909

Yellow alarm; warning

Cause	Corrective action
Internal engine fault.	► Contact Service.

957 – AL p5 ctrlvar max BOI min active

ZKP-Number: 1.1600.911

Yellow alarm; warning

Cause	Corrective action
Internal engine fault.	► Contact Service.

TTM-ID: 0000047144 - 003

958 – AL Lambda ctrlvar limit min active

ZKP-Number: 1.1600.913

Yellow alarm; warning

Cause	Corrective action
Internal engine fault.	► Contact Service.

959 – AL Lambda ctrlvar max BOI min act

ZKP-Number: 1.1600.915

Yellow alarm; warning

Cause	Corrective action
Internal engine fault.	► Contact Service.

960 – AL NOx p5 min BOI max active

ZKP-Number: 1.1600.917

Yellow alarm; warning

Cause	Corrective action
Internal engine fault.	► Contact Service.

961 – AL NOx p5 max BOI min active

ZKP-Number: 1.1600.919

Yellow alarm; warning

Cause	Corrective action
Internal engine fault.	► Contact Service.

962 – AL GPS Lambda ctrlvar max active

ZKP-Number: 1.1600.921

Yellow alarm; warning

Cause	Corrective action
Internal engine fault.	► Contact Service.

963 – AL GPS p5 ctrlvar max active

ZKP-Number: 1.1600.923

Yellow alarm; warning

Cause	Corrective action
Internal engine fault.	► Contact Service.

964 – AL GPS p5 ctrlvar min active

ZKP-Number: 1.1600.925

Yellow alarm; warning

Cause	Corrective action
Internal engine fault.	► Contact Service.

973 – AL Check Sum IIG

ZKP-Number: 1.1025.902

Yellow alarm; warning

Cause	Corrective action
Wrong injector code.	► Contact Service.

1024 – LOLO P-Fuel (Common RailA)

ZKP-Number: 2.0104.951

Yellow alarm; warning

Cause	Corrective action
Fuel pressure in fuel HP accumulator on A side too low.	<ol style="list-style-type: none">1. Check fuel lines for leakage.2. Drain fuel prefilter (→ Page 91).3. Replace filter element of fuel prefilter (→ Page 92).4. Replace fuel filter (→ Page 89).

1025 – LOLO P-Fuel (Common RailB)

ZKP-Number: 2.0115.911

Yellow alarm; warning

Cause	Corrective action
Fuel pressure in fuel HP accumulator on B side too low.	<ol style="list-style-type: none">1. Check fuel lines for leakage.2. Drain fuel prefilter (→ Page 91).3. Replace filter element of fuel prefilter (→ Page 92).4. Replace fuel filter (→ Page 89).

1027 – AL Engine Cold Active

ZKP-Number: 2.7010.921

Yellow alarm; warning

Cause	Corrective action
Engine temperature is below operating temperature.	<ol style="list-style-type: none">1. Provide additional heating to increase engine temperature.2. Observe coolant temperature.

TTM-ID: 0000047144 - 003

7 Task Description

7.1 Valve Drive

7.1.1 Valve clearance – Check and adjustment

Preconditions

- ☒ Engine is stopped and starting disabled.
- ☒ Engine coolant temperature is max. 40 °C.
- ☒ Valves are closed.

Special tools, Material, Spare parts

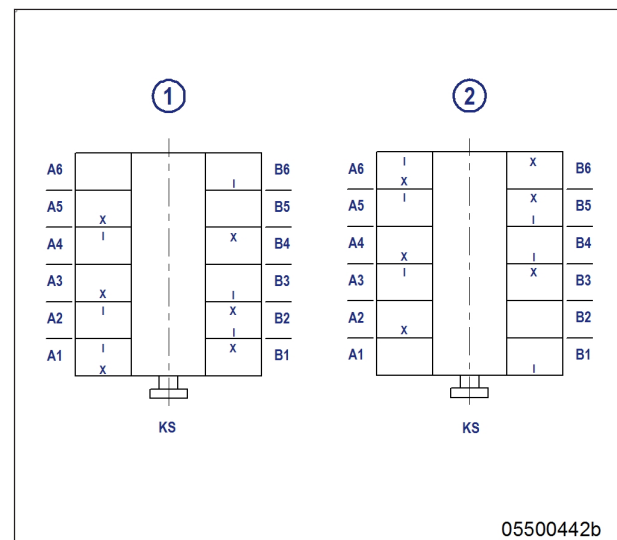
Designation / Use	Part No.	Qty.
Feeler gauge	Y20010128	1
Torque wrench, 20–100 Nm	F30026582	1
Box wrench, 14 mm	F30028346	1
Allen key, 5 mm	F30002815	1
Barring device	F6790714	1

Preparatory steps

- Remove cylinder head cover (→ Page 86).

Diagram for 12V engines (two crankshaft positions)

- 1 Cylinder A1 is in firing TDC
- 2 Cylinder A1 is in overlap TDC
- I Inlet valve
- X Exhaust valve



Checking TDC position of piston in cylinder A1 – Variant (A)

1. Install barring device, variant (A), on flywheel housing, A side bottom (→ Page 34).
2. Rotate crankshaft with barring device in engine direction of rotation until “OT-A1” mark and pointer are aligned.

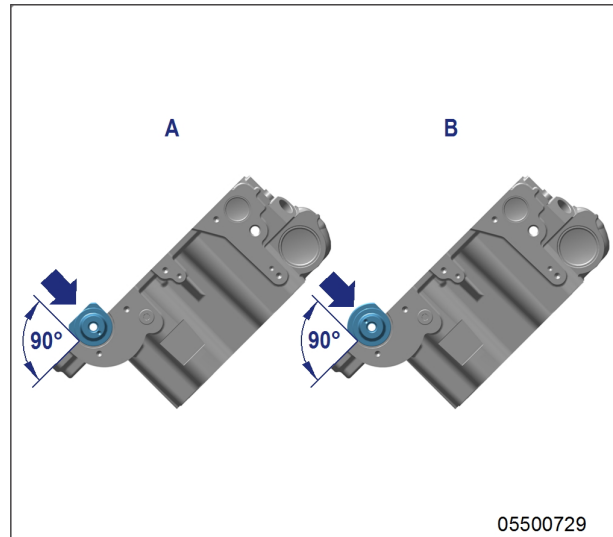
Checking valve clearance – Variant (A)

1. Check TDC position of piston in cylinder A1:
 - If rocker arms on cylinder A1 are unloaded, the piston is in firing TDC.
 - If rocker arms on cylinder A1 are loaded, the piston is in overlap TDC.
2. Check valve clearance with cold engine:
 - Inlet = 0.3 ± 0.05 mm;
 - Exhaust = 0.6 ± 0.05 mm.
3. Check all valve clearances in two crankshaft positions (firing TDC and overlap TDC of cylinder A1) as per diagram.
4. Use feeler gauge to determine the distance between valve bridge and rocker arm.
5. If the deviation from the reference value exceeds 0.1 mm, adjust valve clearance.

Checking TDC position of piston in cylinder A1 – Variant (B)

1. Install barring device, variant (B), on starter, B side (→ Page 34).

- A Cylinder A1 is in firing TDC
B Cylinder A1 is in overlap TDC



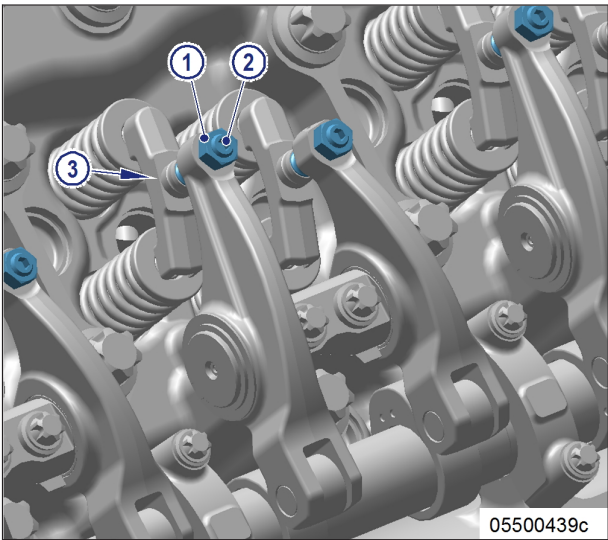
2. Bar engine manually in direction of rotation of the engine until the straight surface (arrow) points upwards and the angle between the adjustment aid and the cylinder head is 90° (Figure A).
3. Continue to turn the crankshaft until the rounded surface (arrow) points upwards and the angle between the adjustment aid and the cylinder head is 90° (Figure B).

Checking valve clearance – Variant (B)

1. Check valve clearance with cold engine:
 - Inlet = 0.3 ± 0.05 mm;
 - Exhaust = 0.6 ± 0.05 mm.
2. Check all valve clearances in two crankshaft positions (firing TDC and overlap TDC of cylinder A1) as per diagram.
3. Use feeler gauge to determine the distance between valve bridge and rocker arm.
4. If the deviation from the reference value exceeds 0.1 mm, adjust valve clearance.

Adjusting valve clearance

- 1. Loosen locknut (1) and unscrew adjusting screw (2) by a few threads.
- 2. Insert feeler gauge between valve bridge and rocker arm (3).
- 3. Readjust adjusting screw (2) so that the feeler gauge just passes through the gap.



- 4. Tighten locknut (1) with torque wrench to specified torque, holding adjusting screw (2) firm with Allen screw.

Name	Size	Type	Lubricant	Value/Standard
Nut	M10 x 1	Tightening torque		43 Nm +4 Nm

- 5. Check if the feeler gauge just passes through between valve bridge and rocker arm (3).
- Result: If not, adjust valve clearance.

Final steps

- 1. Remove barring device (→ Page 34).
- 2. Install cylinder head cover (→ Page 86).

7.1.2 Cylinder head cover – Removal and installation

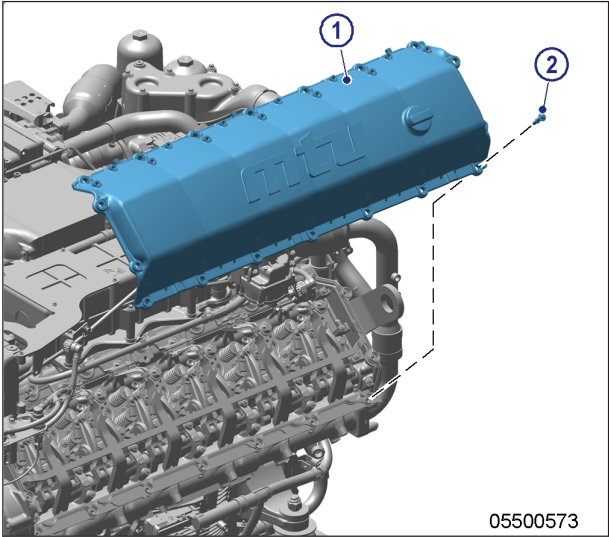
Preconditions

☑ Engine is stopped and starting disabled.

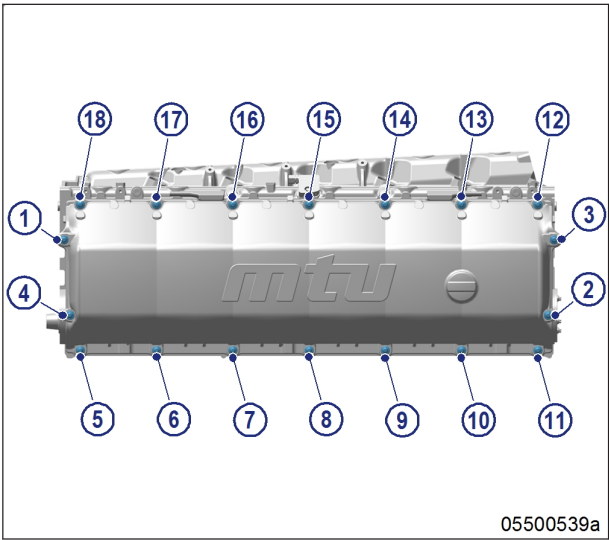
Removing and installing cylinder head cover

Note: Cover the engine beneath the cylinder head with rags to soak up escaping residual oil.

1. Remove screws (2).
2. Remove cylinder head cover (1).
3. Clean mating faces.
4. Check condition of profile gasket and replace if required.



05500573



05500539a

5. Position cylinder head cover and screws at positions 1 to 4 and tighten to specified initial tightening torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw with twin collar	M8	Preload torque		10 Nm

6. Tighten screws at positions 1 to 18 to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw with twin collar	M8	Tightening torque		20 Nm ±2 Nm

Consecutive tightening sequence starting at position 1:	1 to 18
---	---------

7.2 Fuel System

7.2.1 Fuel system – Venting

Preconditions

- ☒ Engine is stopped and starting disabled.
- ☒ Engine cooled down to ambient temperature.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 4–20 Nm	F30044239	1
Ratchet adapter	F30027340	1

WARNING



Fuels are combustible.

Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Venting fuel prefilter

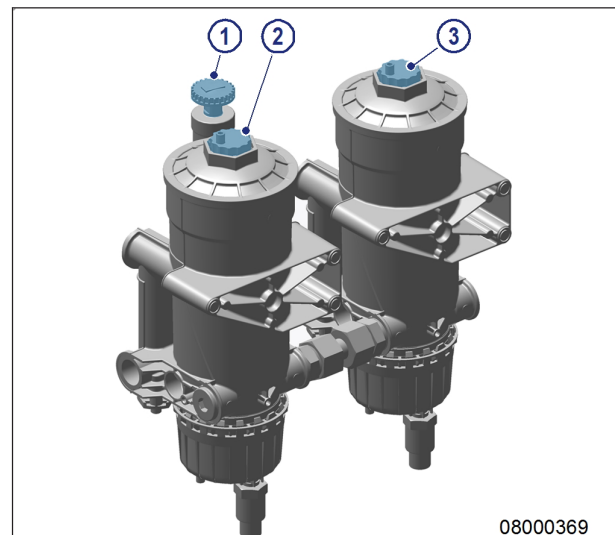
1. Unlock fuel priming pump, screw out handle (1).

Note: Catch emerging fuel with a suitable cloth.

2. Loosen threaded vent plug (2) and screw out by approx. 3 to 4 turns.
3. Operate the pump with the handle (1) until bubble-free fuel emerges from the vent plug (2).
4. Close threaded vent plug (2) and tighten by hand.

Note: Catch emerging fuel with a suitable cloth.

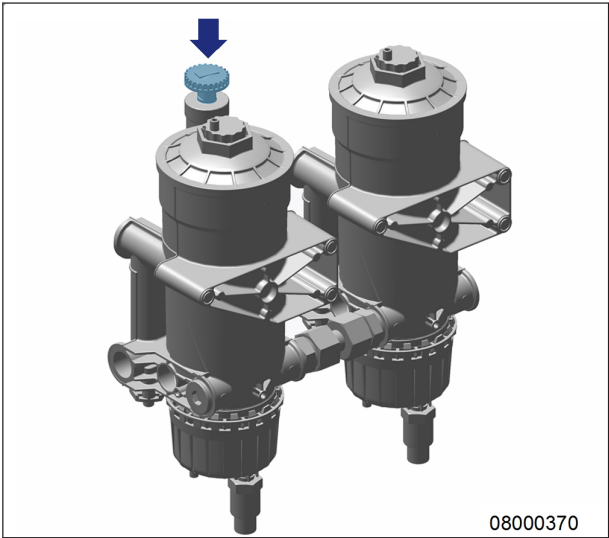
5. Loosen threaded vent plugs (3) and screw out by approx. 3 to 4 turns.
6. Operate the pump with the handle (1) until bubble-free fuel emerges from the vent plug (2).
7. Close threaded vent plug (2) and tighten by hand.



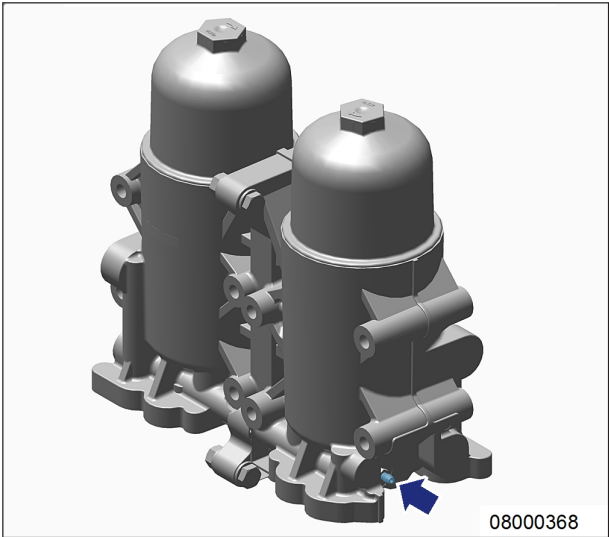
08000369

Venting fuel filter

- 1. Unlock fuel priming pump, unscrew handle (arrow).



- 2. Provide a suitable container in which to collect the fuel.
- Note: Do not remove threaded vent plug.
- 3. Open threaded vent plug (arrow).



- 4. Screw in threaded vent plug (arrowed) and tighten to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Threaded vent plug	10	Tightening torque		6.5 Nm ±1.3 Nm

7.3 Fuel Filter

7.3.1 Fuel filter – Replacement

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ Engine cooled down to ambient temperature.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 4–20 Nm	F30044239	1
Torque wrench, 20–100 Nm	F30026582	1
Ratchet adapter	F30027340	1
Socket, 32 mm	F30006120	1
Engine oil		
Fuel filter element	(→ Spare Parts Catalog)	2

WARNING



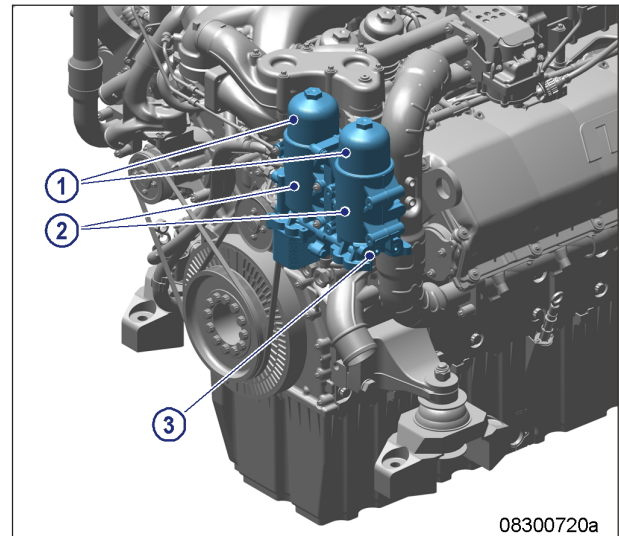
Fuels are combustible.

Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Fuel filter – Replacement

1. Remove drain screw (3).
2. Loosen screw cap (1) on fuel filter and unscrew it approx. 3 to 4 turns.
3. Wait 10 minutes, until fuel has drained from filter housing (2).
4. Remove threaded cover (1).
5. Remove fuel filter element.
6. Check condition of the sealing ring on the threaded cover (1).
7. Replace sealing ring, if damaged.
8. Coat sealing ring with engine oil.
9. Screw in new fuel filter element in filter housing (2) and tighten by hand.



08300720a

10. Screw threaded cover (1) onto filter housing (2) and use torque wrench to tighten to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Threaded cover	32 A/F	Tightening torque	(Engine oil)	40 Nm ±5 Nm

11. Install drain plug (3) and tighten with torque wrench to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Drain plug	10	Tightening torque		6.5 Nm ±1.3 Nm

12. Vent fuel system (→ Page 87).

7.3.2 Fuel prefilter – Drain condensate

Preconditions

- ☑ Engine is stopped and starting disabled.

WARNING



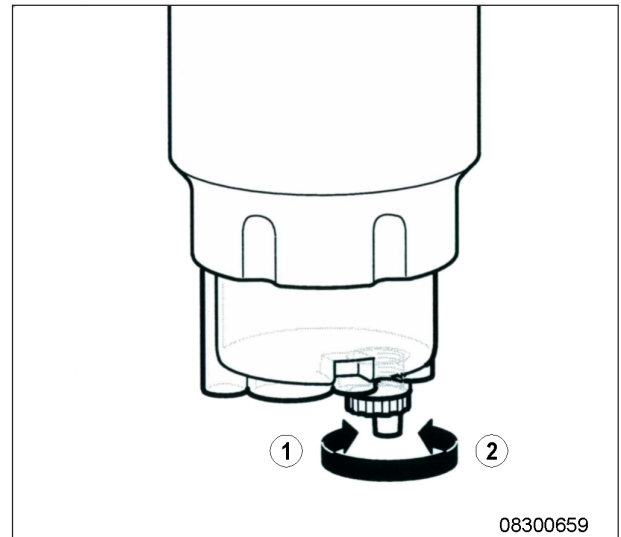
Fuels are combustible.

Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Draining condensate from fuel prefilter

1. Provide a suitable container to collect the water.
2. Open drain screw (1).
3. Allow water to drain off.
4. Screw in and close drain screw (2).



7.3.3 Fuel prefilter – Filter element replacement

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 8–40 Nm	F30043446	1
Ratchet adapter	F30027340	1
Diesel fuel		
Filter element	(→ Spare Parts Catalog)	
Sealing ring	(→ Spare Parts Catalog)	

WARNING



Fuels are combustible.

Risk of fire and explosion!

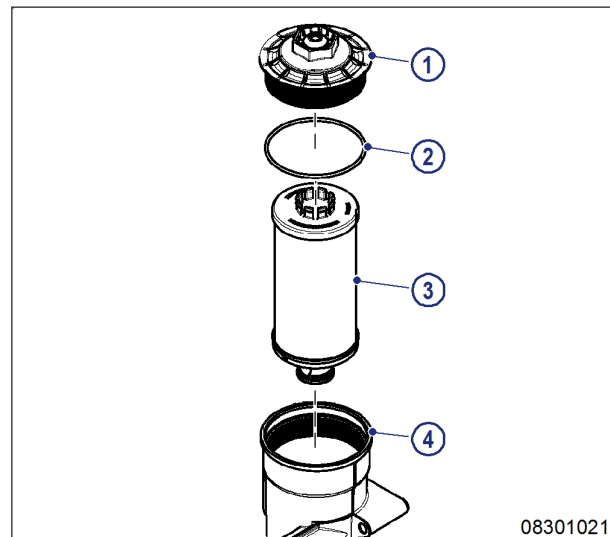
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

Preparatory step

- Provide a suitable container in which to collect the fuel.

Replacing fuel prefilter

1. Close fuel supply.
2. Unscrew filter cover (1).
3. Remove filter cover (1) with filter element (3) from filter housing.
4. Remove filter element (3) from filter cover (1).
5. Install new O-ring (2) on filter cover (1).
6. Coat new O-ring (2) with fuel.
7. Insert new filter element (3) in filter cover (1).
8. Screw in filter cover (1) with filter element (3) into filter housing.



9. Tighten filter cover (1) with torque wrench to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Filter cover		Tightening torque		40 Nm

Final steps

1. Open fuel supply.
2. Vent fuel system (→ Page 87).

TTM-ID: 0000045411 - 004

7.4 Air Filter

7.4.1 Air filter element – Removal and installation (optional)

Preconditions

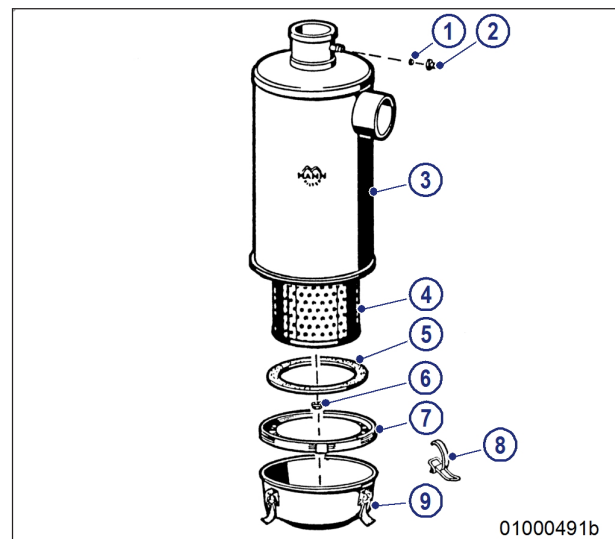
- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Sealing	(→ Spare Parts Catalog)	

Air filter element – Removal and installation

1. Release latches (9).
2. Remove dust bowl (8) and partition (7).
3. Remove collar nut (6).
4. Screw off air filter element (4).
5. Clean housing (3) and dust bowl (8).
6. Check seal (5) for damage and cleanness, replace if necessary.
7. Clean all mating and sealing surfaces.
8. Fit partition (7) and dust bowl (9) according to marking.
9. Secure dust bowl (9) with latches (8).



7.4.2 Air filter element and (optional) dust bowl - Cleaning

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Sealing	(→ Spare Parts Catalog)	

WARNING



Compressed air gun ejects a jet of pressurized air.

Risk of injury to eyes and damage to hearing, risk of rupturing internal organs!

- Never direct air jet at people.
- Always wear safety goggles/face mask and ear defenders.

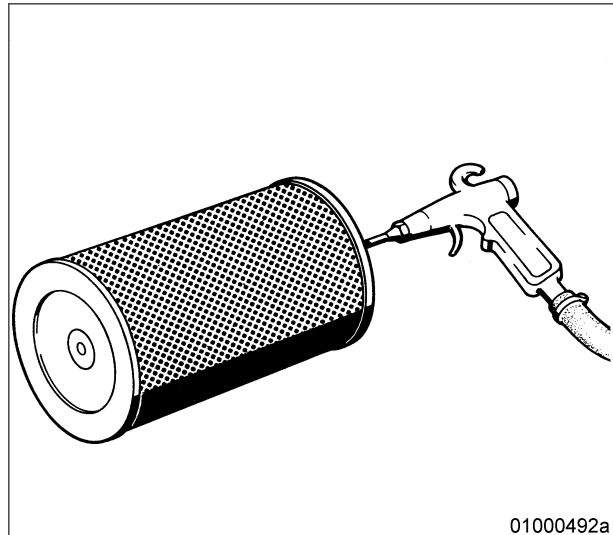
Air filter element – Cleaning

Note: Clean paper filter element dry only.

1. Open air filter and remove filter element (→ Page 93).
2. Check seal for damage and cleanness, replace if necessary.
3. Clean all mating and sealing surfaces.

Note: Debris particles must not enter the intake system.

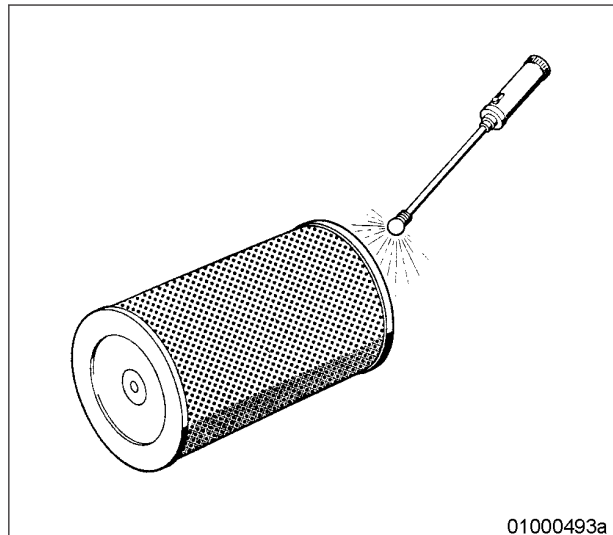
4. Clean dust bowl (if fitted).
5. Blow out filter element with compressed air (max. 3 bar) from inside until all dust has been removed.
6. Fit new filter element if old one is heavily contaminated or damaged (→ Page 95).



01000492a

Visual inspection

1. Use inspection lamp to check cleaned filter element for damage.
2. Fit new filter element if old one is damaged (→ Page 95).



01000493a

TIM-ID: 0000005423 - 006

7.4.3 Air filter – Replacement (option)

Preconditions

- ☒ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Air filter	(→ Spare Parts Catalog)	

Replacing air filter

1. Remove air filter and install new one (→ Page 93).
2. Reset signal ring of service indicator (→ Page 96).

7.5 Air Intake

7.5.1 Service indicator – Signal ring position check

Preconditions

- ☑ Engine is stopped and starting disabled.

Checking signal ring position

1. Replace air filter if the signal ring (2) is completely visible in the red area of the observation window (3) (→ Page 95).
2. After installation of new filter, press reset button (1).

Result: Signal ring returns to initial position.



7.6 Lube Oil System, Lube Oil Circuit

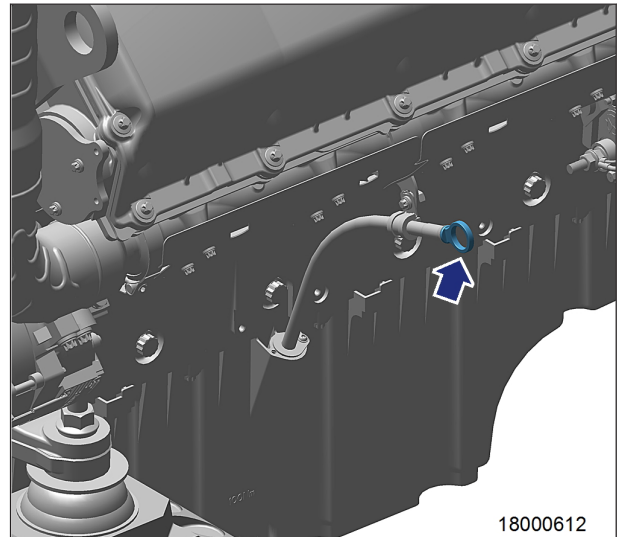
7.6.1 Engine oil level – Check

Preconditions

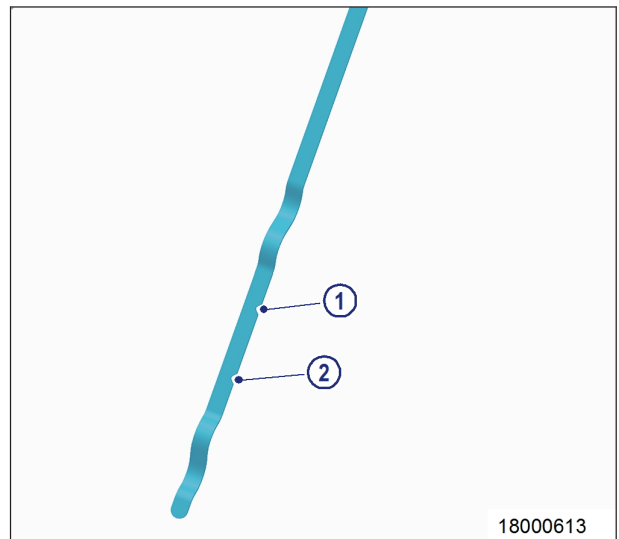
- ☑ Engine is stopped and starting disabled.

Checking oil level prior to engine start

1. Withdraw oil dipstick (arrow) from guide tube and wipe it.
2. Insert oil dipstick (arrow) into guide tube up to the stop, withdraw after approx. 10 seconds and check oil level.



3. Oil level must be between "min." (2) and "max." (1) marks.
4. If necessary, top up to the "max." (2) mark(→ Page 98).
5. Insert oil dipstick (1) in guide tube up to the stop.



Checking oil level after the engine is stopped

1. 5 minutes after stopping the engine, remove oil dipstick (1) from the guide tube and wipe it.
2. Insert oil dipstick (1) into guide tube up to the stop, withdraw after approx. 10 seconds and check oil level.
3. Oil level must be between "min." and "max." marks.
4. If necessary, top up to "max." mark (→ Page 98).
5. Insert oil dipstick (1) in guide tube up to the stop.

7.6.2 Engine oil – Change

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ Engine is at operating temperature.
- ☑ MTU Fluids and Lubricants Specifications (A001063/..) are available.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine oil		

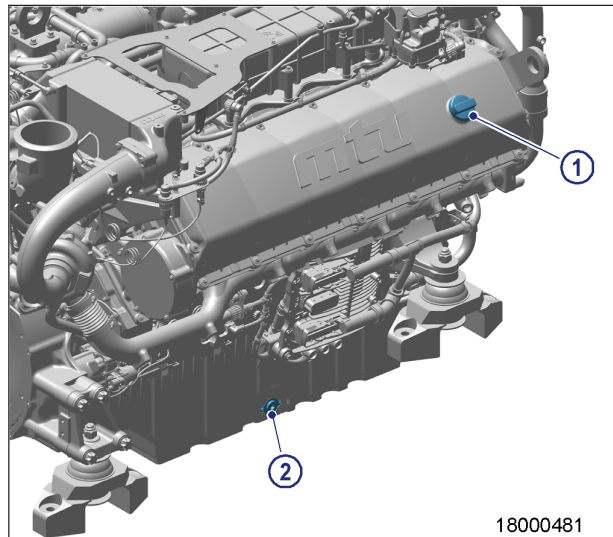
WARNING



- Hot oil.
Oil can contain combustion residues which are harmful to health.
- Risk of injury and poisoning!**
- Wear protective clothing, gloves, and goggles / safety mask.
 - Avoid contact with skin.
 - Do not inhale oil vapor.

Draining oil via drain plug on oil pan

1. Provide a suitable container to collect the oil.
2. Remove drain plug (2) and drain oil.



18000481

3. Insert drain plug (2) and use torque wrench to tighten to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Drain plug	M26x1.5	Tightening torque	(Engine oil)	100 Nm

4. Replace engine oil filter (→ Page 99).

Filling with new oil

1. Open cap (1) on cylinder head cover.
2. Fill with oil, oil quantity (→ Page 23).
3. Close cap (1) on cylinder head cover.
4. Check engine oil level (→ Page 97).

TTM-ID: 0000035571 - 002

7.7 Oil Filtration / Cooling

7.7.1 Engine oil filter - Replacement

Preconditions

- ☒ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 8–40 Nm	F30043446	1
Ratchet adapter	F30027340	1
Socket, 32 mm	F30006120	1
Engine oil		
Oil filter element	(→ Spare Parts Catalog)	

WARNING



Hot oil.

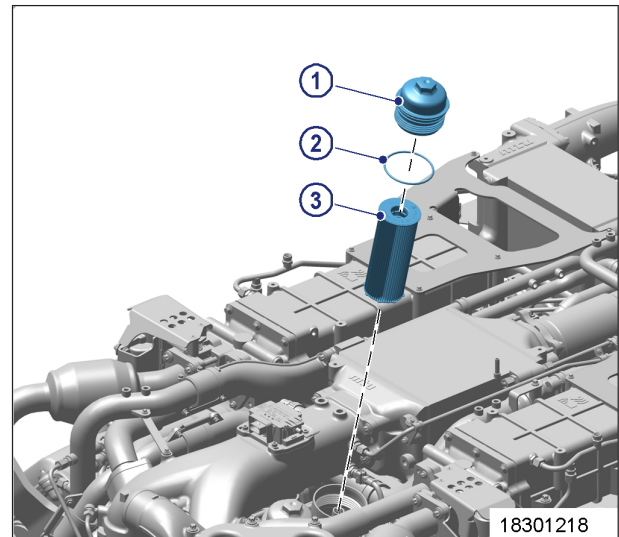
Oil can contain combustion residues which are harmful to health.

Risk of injury and poisoning!

- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

Engine oil filter - Replacement

1. Unscrew the oil filter covers (1) approx. 3 to 4 revolutions.
2. Wait 10 minutes until the oil has drained from the filter housings.
3. Take off threaded cover (1) with oil filter element (3).
4. Pull oil filter element (3) to detach it from threaded cover (1).
5. Check condition of sealing ring (2) on cover.
6. Replace sealing ring (2) if damaged.
7. Coat sealing ring (2) with oil.
8. Insert new oil filter element (3) in cover (1) and press in until it locks in place.



9. Screw on threaded cover (1) with oil filter element (3) and tighten to the specified torque with a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Threaded cover	32 A/F	Tightening torque	(Engine oil)	35 Nm \pm 3.5 Nm

10. Replace other engine oil filters in the same way.
11. Check oil level (→ Page 97)

7.8 Coolant Circuit, General, High-Temperature Circuit

7.8.1 Engine coolant – Level check

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ MTU Fluids and Lubricants Specifications (A001063/..) are available.

WARNING



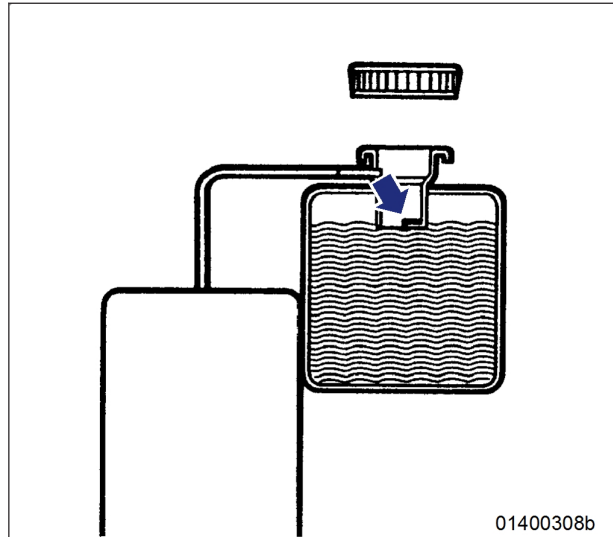
Coolant is hot and under pressure.

Risk of injury and scalding!

- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Checking engine coolant level at filler neck

1. Turn breather valve on coolant expansion tank counterclockwise to the first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Check coolant level (coolant must be visible at the lower edge of the cast-in eye or at the marking plate).
4. Top up with treated coolant as necessary (→ Page 104).
5. Check breather valve (visual inspection) and clean if necessary.
6. Position breather valve on filler neck and close.



Checking engine coolant level by means of level sensor

1. Switch on engine control system and check readings on the display.
2. Top up with treated coolant as necessary (→ Page 104).

7.8.2 Engine coolant – Change

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Coolant		

Engine coolant change

1. Drain engine coolant (→ Page 102).
2. Fill with engine coolant (→ Page 104).

7.8.3 Engine coolant – Draining

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Sealing ring	(→ Spare Parts Catalog)	

WARNING



Coolant is hot and under pressure.

Risk of injury and scalding!

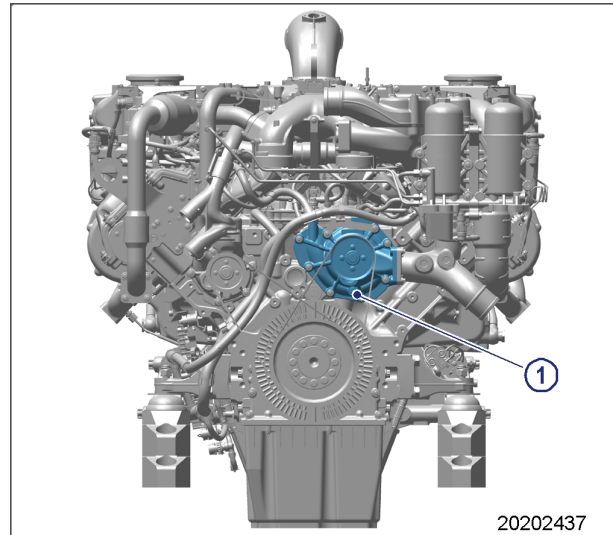
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Preparatory steps

1. Provide a suitable container to catch the coolant.
2. Switch off preheater, if installed.

Engine coolant – Draining

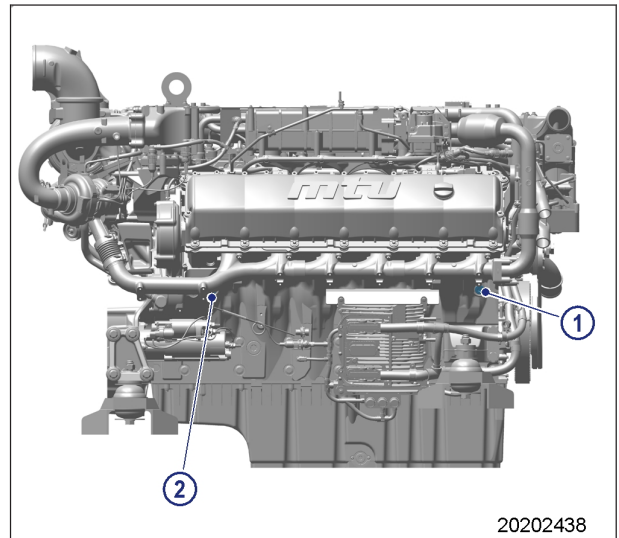
1. Turn breather valve of filler neck on coolant expansion tank counterclockwise to first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Draw off separated corrosion inhibitor oil in expansion tank through the filler neck.
4. Open drain plug and drain off coolant at engine coolant pump (1).



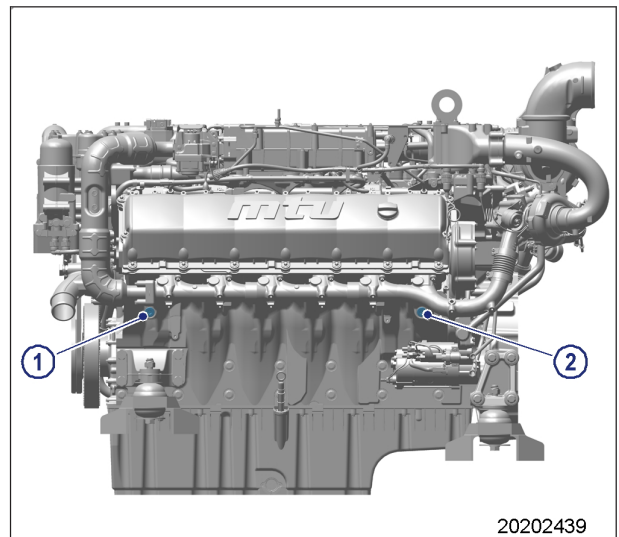
20202437

TIM-ID: 0000035572 - 002

5. Open drain plugs and drain coolant at crankcase, right side (1,2).



6. Open drain plugs and drain coolant at crankcase, left side (1,2).
7. Install drain plug with new sealing ring.
8. Position breather valve on filler neck and close.



7.8.4 Engine coolant – Filling

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ MTU Fluids and Lubricants Specifications (A001063/..) are available.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Coolant		

WARNING



Coolant is hot and under pressure.

Risk of injury and scalding!

- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

WARNING



High level of engine noise when the engine is running.

Risk of damage to hearing!

- Wear ear protectors.

NOTICE



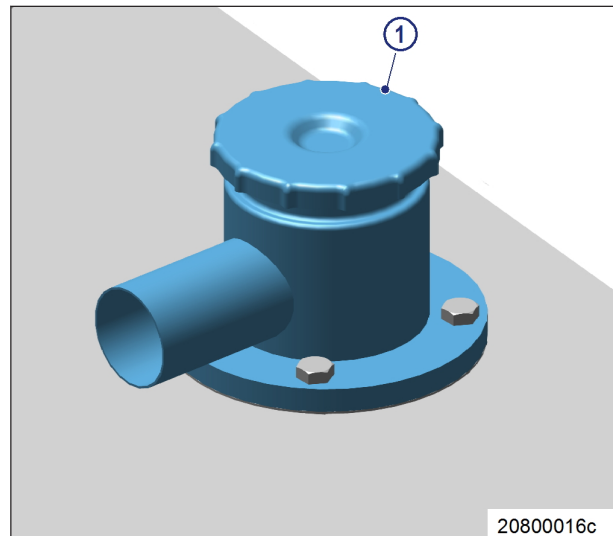
Cold coolant in hot engine can cause thermal stress.

Possible formation of cracks in the engine!

- Fill / top up coolant only into cold engine.

Preparatory steps

1. Turn breather valve (1) of coolant expansion tank counterclockwise until the first stop and allow pressure to escape.
2. Continue to turn valve cover (1) counterclockwise and remove.



Coolant – Filling

1. Fill coolant through filler neck on expansion tank or through filling line until coolant level reaches lower edge of cast-in eye or marking plate.
2. Check proper condition of breather valve (1), clean sealing faces if required.
3. Fit breather valve (1) and close it.

TTM-ID: 0000000909 - 007

Final steps

1. Start the engine and operate it at idle speed for some minutes.
2. Check coolant level (→ Page 100), top up with coolant if required.

7.8.5 Engine coolant pump – Relief bore check

DANGER



Rotating and moving engine parts.

Risk of crushing, danger of parts of the body being caught or pulled in!

- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING



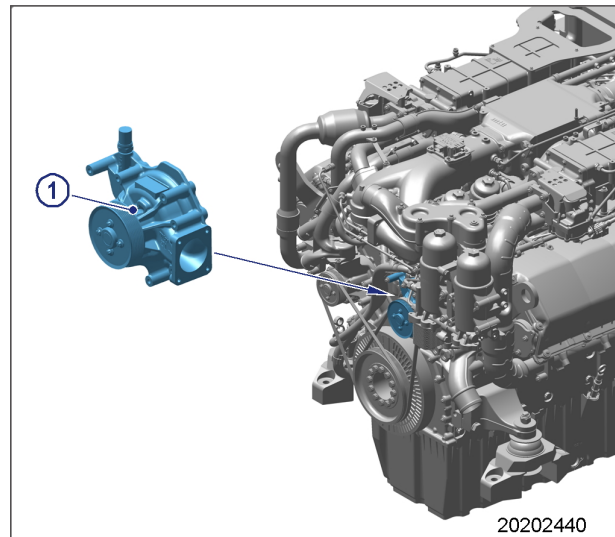
High level of engine noise when the engine is running.

Risk of damage to hearing!

- Wear ear protectors.

Engine coolant pump – Relief bore check

1. Check relief bore (1) for coolant discharge.
 - Permissible coolant discharge quantity:
Up to 0.1 ml per hour respectively
100 ml per 1,000 operating hours.
2. Stop engine (→ Page 31) and disable engine start.
3. If discharge exceeds the specified limits, contact Service.



20202440

7.9 Low-Temperature Circuit

7.9.1 Charge-air coolant level – Check

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ MTU Fluids and Lubricants Specifications (A001063/..) are available.

WARNING



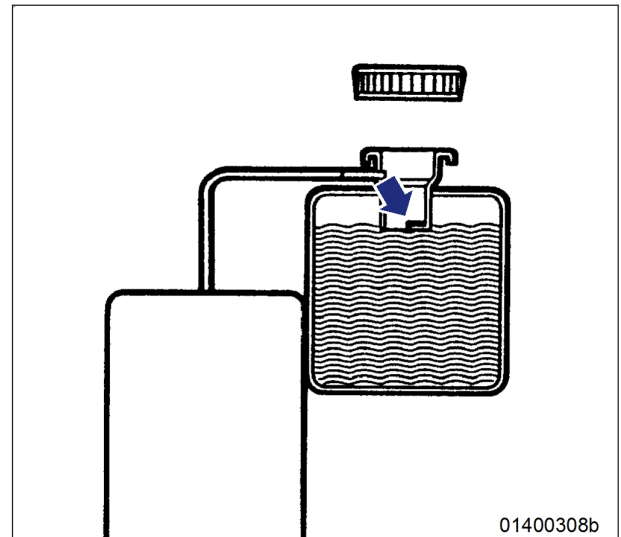
Coolant is hot and under pressure.

Risk of injury and scalding!

- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Checking charge-air coolant level at filler neck

1. Turn breather valve on coolant expansion tank counterclockwise to the first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Check coolant level (coolant must be visible at marker plate).
4. Top up coolant if necessary (→ Page 110).
5. Check satisfactory condition of breather valve, clean sealing faces if required.
6. Fit breather valve and close it.



Checking charge-air coolant level by means of level sensor

1. Switch on engine control system and check display (coolant level is automatically monitored by engine control system).
2. Top up coolant if necessary (→ Page 110).

7.9.2 Charge-air coolant – Change

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Coolant		

Charge-air coolant – Change

1. Drain charge-air coolant (→ Page 109).
2. Fill with charge-air coolant (→ Page 110).

7.9.3 Charge-air coolant – Draining

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Sealing ring	(→ Spare Parts Catalog)	
Sealing ring	(→ Spare Parts Catalog)	

WARNING



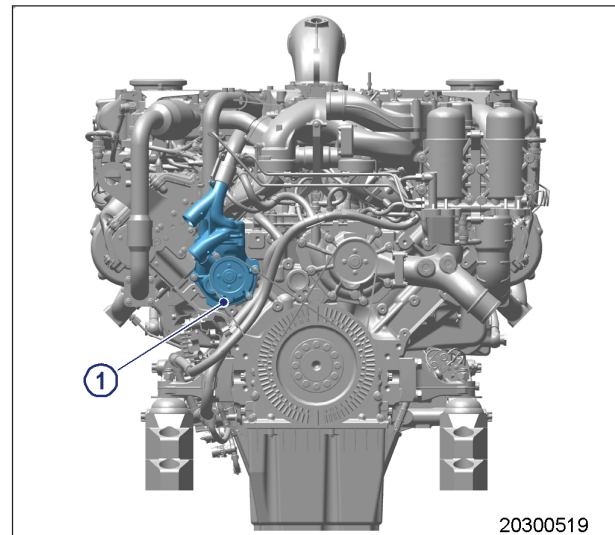
Coolant is hot and under pressure.

Risk of injury and scalding!

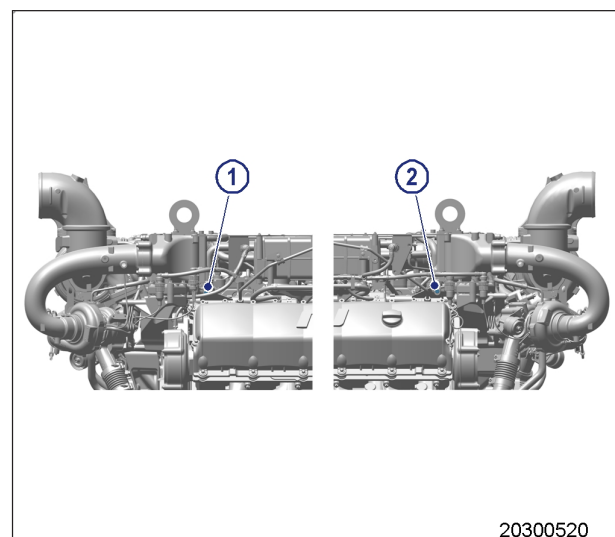
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

Charge-air coolant – Draining

1. Provide an appropriate container to drain the coolant into.
2. Turn breather valve on coolant expansion tank counterclockwise to the first stop and allow pressure to escape.
3. Continue to turn breather valve counterclockwise and remove.
4. Draw off precipitated corrosion inhibitor oil from the expansion tank through filler neck.
5. Open drain screw and drain off coolant at the charge-air coolant pump (1).
6. Open drain plugs and drain coolant on the intercooler, right (1) and left side (2).
7. Screw in drain plugs with new sealing rings.
8. Place breather valve on filler neck and close.



20300519



20300520

7.9.4 Charge-air coolant – Filling

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ MTU Fluids and Lubricants Specifications (A001063/..) are available.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Coolant		
Sealing ring	(→ Spare Parts Catalog)	

WARNING



Coolant is hot and under pressure.

Risk of injury and scalding!

- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

WARNING



High level of engine noise when the engine is running.

Risk of damage to hearing!

- Wear ear protectors.

NOTICE



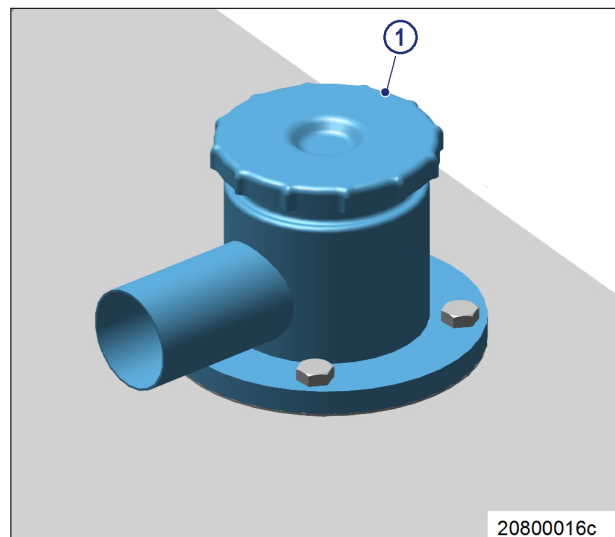
Cold coolant in hot engine can cause thermal stress.

Possible formation of cracks in the engine!

- Fill / top up coolant only into cold engine.

Preparatory steps

1. Turn breather valve (1) on coolant expansion tank counterclockwise to the first stop and allow pressure to escape.
2. Continue to turn breather valve (1) counterclockwise and remove.
3. Remove plug screw from filling point on coolant line to intercooler.



TTM-ID: 0000031875 - 006

Coolant – Filling

1. Fill treated coolant through filling line or through filler neck of coolant expansion tank until coolant level reaches marker plate.
2. Install plug screws of filling points with new sealing rings.
3. Check proper condition of breather valve (1), clean sealing faces if required.
4. Fit breather valve (1) and close it.

Final steps

1. Start the engine and operate it at idle speed for some minutes.
2. Check coolant level (→ Page 107).

7.9.5 Charge-air coolant pump - Relief bore check

DANGER



Rotating and moving engine parts.

Risk of crushing, danger of parts of the body being caught or pulled in!

- Only run the engine at low power. Keep away from the engine's danger zone.

WARNING



High level of engine noise when the engine is running.

Risk of damage to hearing!

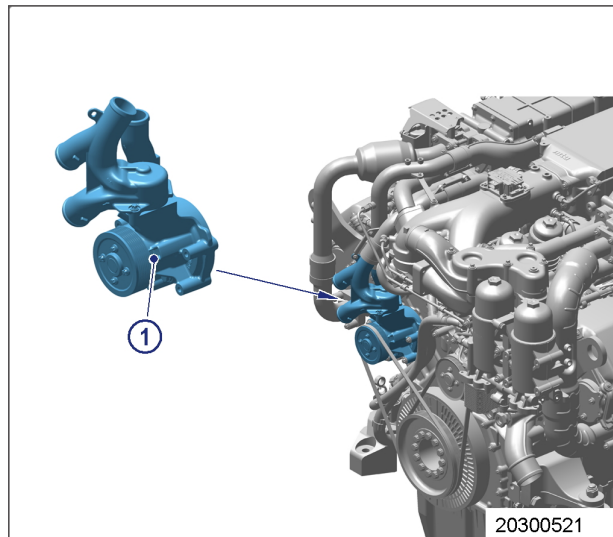
- Wear ear protectors.

Charge-air coolant pump - Relief bore check

1. Check relief bore (1) for coolant discharge.
 - Permissible coolant discharge: Up to 0.1 ml per hour respectively 100 ml per 1,000 operating hours.

Result: If discharge exceeds the specified limits, contact Service.

2. If relief bore (1) is clogged:
 - Stop engine (→ Page 31) and disable engine start.
 - Clean relief bore (1) with wire.



7.10 Belt Drive

7.10.1 Coolant pump – Drive belt replacement

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Assembly jig	F6794712	1
Poly-vee belt	(→ Spare Parts Catalog)	

DANGER



Rotating and moving engine parts.

Risk of crushing, danger of parts of the body being caught or pulled in!

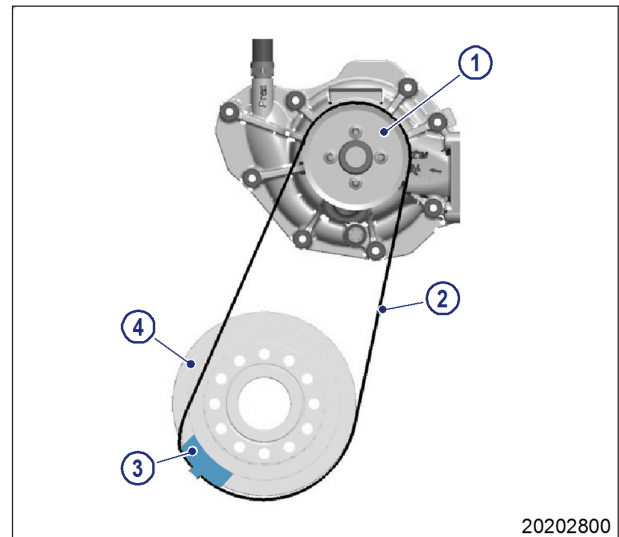
- Before barring the engine, make sure that there are no persons in the engine's danger zone.
- After finishing work on the engine, make sure that all safety devices are put back in place and all tools are removed from the engine.

Preparatory step

1. Install barring gear (→ Page 34).
2. Cut poly-vee belt (2) on charge-air coolant pump and engine coolant pump with a suitable cutting tool.

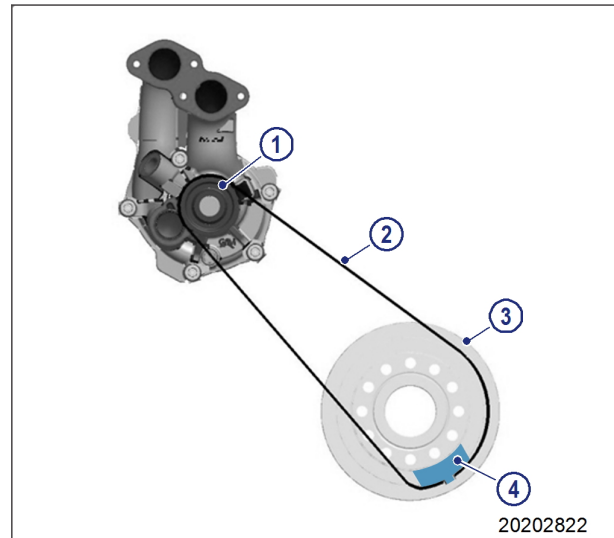
Replacing engine coolant pump drive belt (HT circuit)

1. Fit new poly-vee belt (2) on back four grooves of belt pulley (1) to crankshaft.
2. Fit poly-vee belt (2) on back four grooves of belt pulley (4) to crankshaft and preload with assembly jig (3).
3. Bar engine with barring gear until poly-vee belt (2) lies completely on belt pulley (4).
4. Remove assembly jig (3).



Replacing charge-air coolant pump drive belt (LT circuit)

1. Fit new poly-vee belt (2) on front three grooves of belt pulley (1) to crankshaft.
2. Fit poly-vee belt (2) on front three grooves of belt pulley (3) to crankshaft and preload with assembly jig (4).
3. Bar engine with barring gear until poly-vee belt (2) lies completely on belt pulley (3).
4. Remove assembly jig (4).



Final step

- Install barring gear (→ Page 34).

7.11 Battery-Charging Generator

7.11.1 Battery-charging generator – Belt tensioner and diverter pulley replacement

Preconditions

- ☒ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 20–100 Nm	F30026582	1
Ratchet adapter	F30027340	1
Engine oil		
Belt tensioner	(→ Spare Parts Catalog)	
Diverter pulley	(→ Spare Parts Catalog)	

WARNING



Belt tensioner spring is pretensioned.

Risk of hands being crushed!

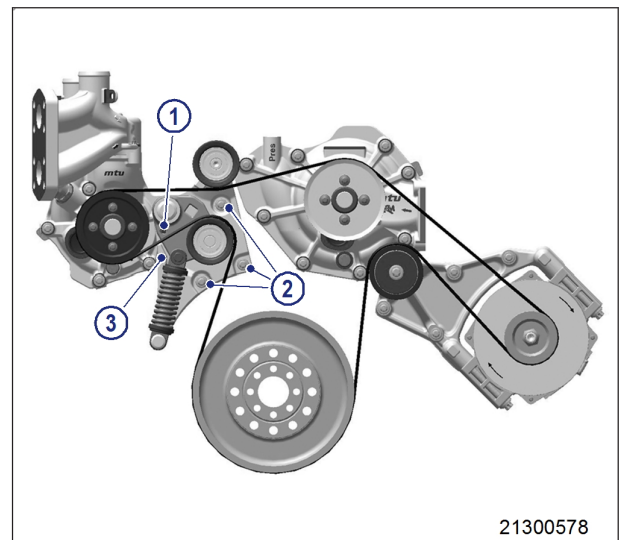
- Lock belt tensioner in position.
- Only use specified tools and devices.

Preparatory step

- ▶ Remove battery-charging generator drive belt (→ Page 117).

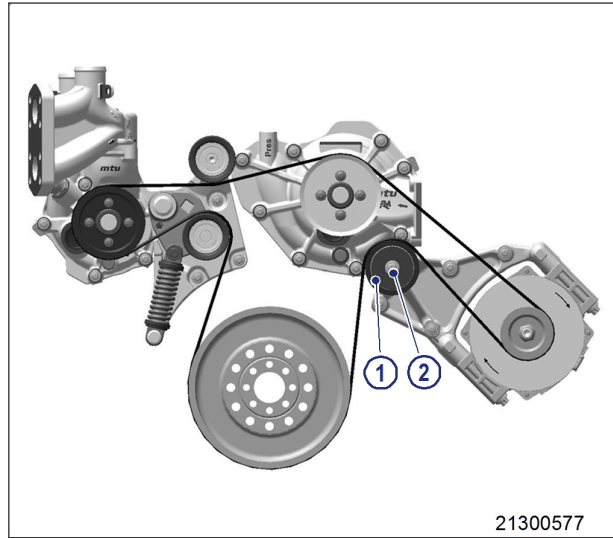
Replacing belt tensioner

1. Install bolts (2).
 2. Remove belt tensioner (3).
- Note: Leave pin (1) in new belt tensioner.
3. Install new belt tensioner (3).
 4. Coat screws (2) with engine oil.
 5. Tighten screws (2).



Replacing diverter pulley

1. Remove screw (2).
2. Remove diverter pulley (1).
3. Coat thread of screw (2) with engine oil.
4. Install new diverter pulley (1) with screw (2).



5. Tighten screw (2) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque	(Engine oil)	60 Nm ± 10 Nm

Final steps

- Note: Remove pin before releasing the belt tensioner.
- Install battery-charging generator drive belt (→ Page 117).

7.11.2 Battery-charging generator – Drive belt removal and installation

Preconditions

- ✓ Engine is stopped and starting disabled.

WARNING



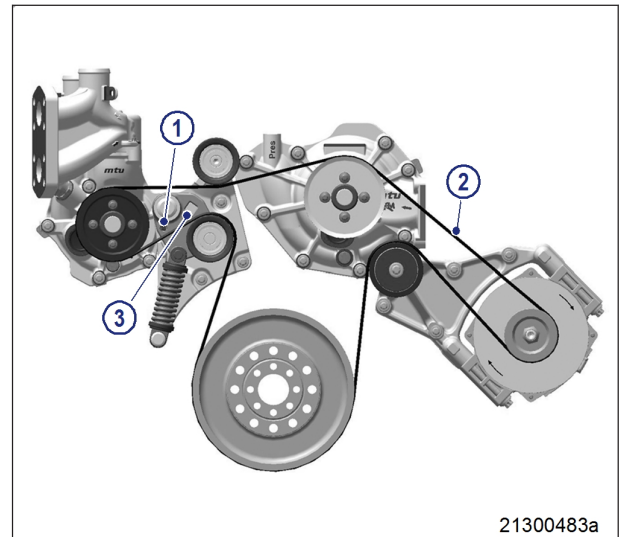
Belt tensioner spring is pretensioned.

Risk of hands being crushed!

- Lock belt tensioner in position.
- Only use specified tools and devices.

Remove battery-charging generator drive belt

1. Fit square wrench with extension into square hole (3) on belt tensioner.
2. Turn belt tensioner clockwise against the spring force almost up to the stop.
3. Insert 8 mm steel pin (e.g. punch) (1) to lock belt tensioner.
4. Remove drive belt (2).
5. Turn belt tensioner clockwise against the spring force almost up to the stop to remove the 8 mm steel pin.
6. Remove 8 mm steel pin.
7. Release belt tensioner and remove square wrench with extension.

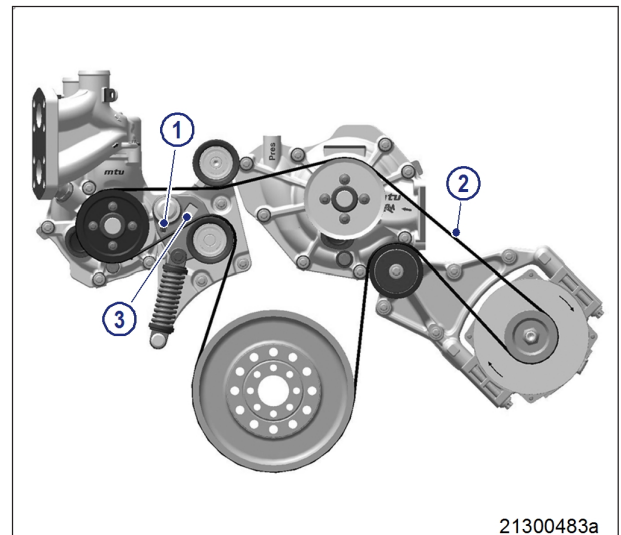


Install battery-charging generator drive belt

1. Fit square wrench with extension into square hole (3) on belt tensioner.
2. Turn belt tensioner clockwise against the spring force almost up to the stop.
3. Insert 8 mm steel pin (e.g. punch) (1) to lock belt tensioner.

Note: When placing the drive belt in the grooves, no force must be applied.

4. Fit new drive belt (2).
5. Turn belt tensioner clockwise against the spring force almost up to the stop to remove the 8 mm steel pin.
6. Remove 8 mm steel pin.
7. Release belt tensioner and remove square wrench with extension.
8. Make sure that drive belt (2) is correctly seated in the grooves.



7.12 Drive Systems, Driving End and Free End (Coupling)

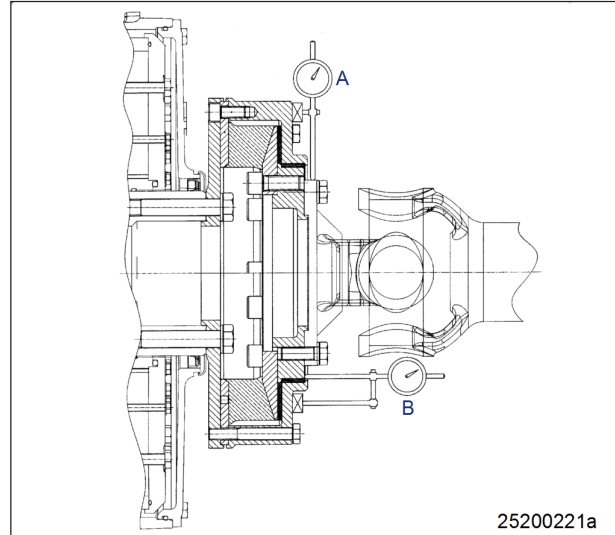
7.12.1 Coupling - Checking (radial / axial) play

Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ Guard is removed.

Checking radial play “A”

1. Mount dial gauge on engine-side coupling flange.
2. Set dial-gauge anvil onto outer coupling part.
3. Push coupling inner part over the drive-shaft connecting flange upwards towards the dial gauge. Use a suitable tool to move the connecting flange (mounting lever).
4. Set dial gauge to zero.
5. Press connecting flange in opposite direction.
6. Take reading on dial gauge.
7. Carry out this measuring procedure two times with the measuring points arranged 90 degrees from each other.
8. Bearing bushing wear is equal to the half of the measured value. If the measured value exceeds 0.3 mm (0.15 mm wear), contact Service.



Checking axial play “B”

1. Mount dial gauge on engine-side coupling flange.
2. Set dial-gauge anvil onto coupling front face.
3. Push inner coupling part over the drive-shaft connecting flange towards the dial gauge. Apply little force when doing so.
4. Set dial gauge to zero.
5. Press inner coupling part in opposite direction.
6. Take reading on dial gauge.
7. Repeat measurement several times.
8. If measurement reveals play in coupling, contact Service.

7.13 Wiring (General) for Engine/Gearbox/Unit

7.13.1 Engine cabling - Check

Preconditions

- ☒ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Solvent (isopropyl alcohol)	X00058037	1

Engine cabling - Check

1. Check securing screws of cable clamps on engine and tighten loose threaded connections.
2. Ensure that cables are fixed in their clamps and cannot swing freely.
3. Check if all cable clips are closed and intact.
4. Replace faulty cable clips.
5. Check that cable clamps are firm, tighten loose cable clamps.
6. Replace faulty cable clamps.
7. Visually inspect the following electrical line components for damage:
 - Connector housing
 - Contacts
 - Sockets
 - Cables and terminals
 - Plug-in contacts

Result: Contact Service if cable conductors are damaged.

Note: Close male connectors that are not plugged in with the protective cap supplied.

8. Clean dirty connector housings, sockets and contacts using isopropyl alcohol.
9. Ensure that all sensor connectors are securely engaged.

7.14 Accessories for (Electronic) Engine Governor / Control System

7.14.1 Injector functions

Preconditions

- ☑ Engine is stopped and starting disabled.

Note: Failure to reset drift compensation parameters (CDC) will void the emissions certification for the engine.

Resetting drift correction parameters (CDC) with DiaSys®

1. (→ Dialog system DiaSys® E531920/..).
2. If no DiaSys® is available, contact Service.

Entering injector coding (IIG)

1. (→ Dialog system DiaSys® E531920/..).
2. If no DiaSys® is available, contact Service.

7.14.2 Engine governor and connectors – Cleaning

Preconditions

- ☒ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Solvent (isopropyl alcohol)	X00058037	1

Note: Always use test connectors to enter the connectors. Never use test leads for this purpose. Otherwise the contacts could be bent.

Engine governor and connectors – Cleaning

1. Remove coarse dirt from housing surface using a cloth moistened with isopropyl alcohol.
2. Remove dirt from the connector and cable surfaces with isopropyl alcohol.
3. Check legibility of cable labels. Clean or replace illegible labels.

Cleaning severely contaminated connectors on the engine governor

- Note: Seal unused connectors with the supplied protective cap.
1. Release the latch and pull off connectors.
 2. Clean connector housings, connector socket housings and all contacts with isopropyl alcohol.
 3. When connectors, sockets and all contacts are dry: Fit connectors and latch them.

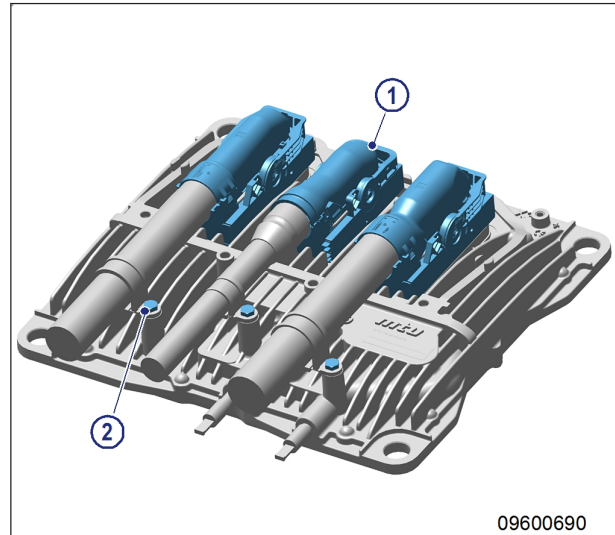
7.14.3 Engine governor – Checking plug-in connections

Preconditions

- ☑ Engine is stopped and starting disabled.

Checking plug-in connections on engine governor

1. Check firm seating of all connectors on the engine governor. Ensure that the clips (1) are engaged.
2. Check firm seating of all screws (2) on engine governor cable clamps. Make sure that cable clamps are not defective.



7.14.4 NOx sensor – Replacement

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 20–100 Nm	F30026582	1
Ratchet adapter	F30027340	1
Assembly compound (Molykote P 37)	50564	1
NOx sensor	(→ Spare Parts Catalog)	1

WARNING



Hot components/surfaces.

Risk of burns!

- Allow the engine to cool down to below 50 °C before beginning work.
- Wear suitable protective equipment/thermal gloves.
- Avoid unprotected contact with hot surfaces.

NOTICE



High voltage.

Risk of damage to components!

- Switch off ignition before replacing components.

NOTICE



Ceramic cell breakage due to shock or impact.

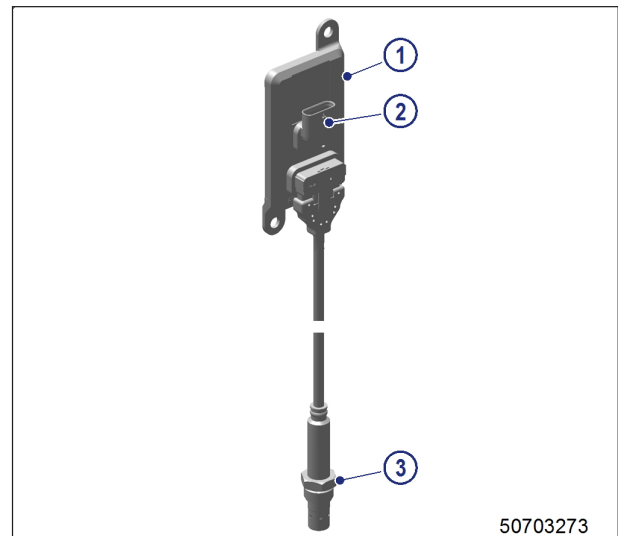
Risk of damage to components!

- Avoid shocks and impacts.
- Exercise extreme care when handling sensors.

Removing NOx sensor

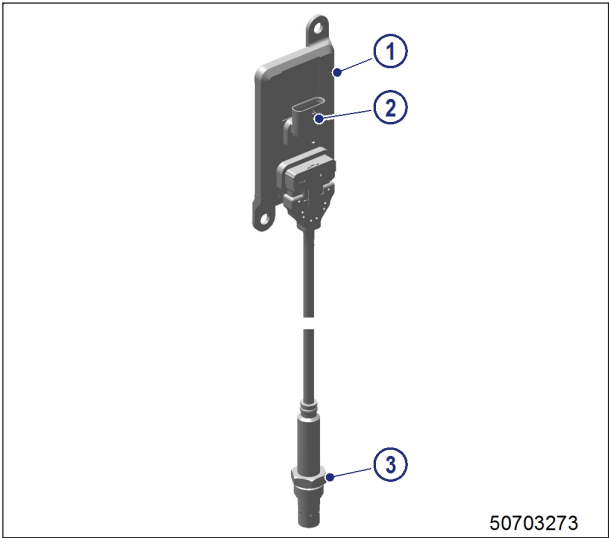
Note: Observe arrangement and position of sensor (→ Page 18).

1. Disconnect and remove male connector (2) from control unit (1).
2. Unscrew control unit (1) at the eyelets.
3. Remove sensor (3).



50703273

Installing NOx sensor



- Note: Note the following:
- If the sensor (3) was subjected to shock or impact load, it is considered to be defective and may not be used.
 - Always replace NOx sensor (3) together with control unit (1).
1. Install control unit (1) at the eyelets and tighten screws to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M6	Tightening torque		max. 12 Nm

2. Remove protective cap on thread of sensor (3) only just before installation.
- Note: Do not wipe off the thread lubricant applied by the manufacturer.
3. Coat sensor (3) thread with specified assembly compound as required.
4. Screw in sensor (3) by hand.
5. Tighten nut (3) with torque wrench to specified tightening torque .

Name	Size	Type	Lubricant	Value/Standard
Nut	M20 x 1.5	Tightening torque	(Assembly compound (Molykote P 37))	50 Nm ± 10 Nm

6. Fit male connector (2) and latch it.

7.14.5 Lambda sensor – Replacement

Preconditions

- ☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 20–100 Nm	F30026582	1
Ratchet adapter	F30027340	1
Assembly compound (Molykote P 37)	50564	1
Lambda sensor	(→ Spare Parts Catalog)	1

WARNING



Hot components/surfaces.

Risk of burns!

- Allow the engine to cool down to below 50 °C before beginning work.
- Wear suitable protective equipment/thermal gloves.
- Avoid unprotected contact with hot surfaces.

NOTICE



Ceramic cell breakage due to shock or impact.

Risk of damage to components!

- Avoid shocks and impacts.
- Exercise extreme care when handling sensors.

NOTICE



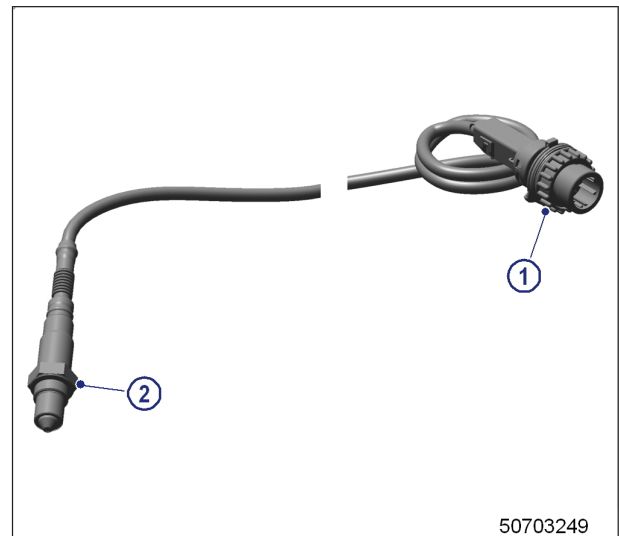
High voltage.

Risk of damage to components!

- Switch off ignition before replacing components.

Removing Lambda sensor

1. Observe the following general information:
 - Layout and position of sensor (→ Page 18).
2. Unplug and remove male connector (1).
3. Remove sensor (2).



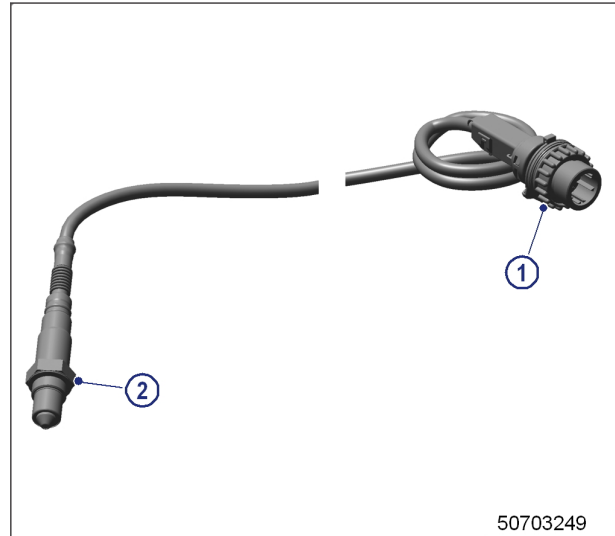
Installing Lambda sensor

Note: When the sensor was subjected to shock or impact load, it is deemed to be defective and may not be used.

1. Remove protective cap on thread only just before installation.

Note: Do not wipe off the thread lubricant applied by the manufacturer.

2. Coat sensor thread with specified assembly compound as required.
3. Screw in sensor by hand.



4. Tighten nut (2) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Nut	M18 x 1.5	Tightening torque	(Assembly compound (Molykote P 37))	40 Nm to 60 Nm

5. Fit male connector (1) and latch it.
6. Reset Lambda sensor with DiaSys® (→ Dialog system DiaSys® E531920/..).

8 Appendix A

8.1 Abbreviations

Abbreviation	Meaning	Explanation
AC	Alternating Current	
AdBlue	-	Brand name of the German Association of Vehicle Manufacturers (VDA) Urea solution with 32.5% urea concentration
AL	Alarm	
ANSI	American National Standards Institute	Association of American standardization organizations
BDM	Backup Data Module	Data backup module
BR	Series	
BV	Betriebsstoffvorschrift	Fluids and Lubricants Specifications, MTU publication no. A00..
CAN	Controller Area Network	Data bus system, bus standard
CaPoS	Capacitor Power System	Capacitor-based starting system
CDC	Calibration Drift Compensation	Drift compensation must be reset in the engine governor using DiaSys® to ensure optimum emissions and consumption characteristics.
CRC	Cyclic Redundancy Control	Check sum procedure to detect data transmission faults
DC	Direct Current	
DEF	Diesel Exhaust Fluid	Urea solution with 32.5% urea concentration Designation used in Northern America
DIFF	Difference	
DIN	Deutsches Institut für Normung e. V.	At the same time identifier of German standards (DIN = "Deutsche Industrie-Norm")
DL	Default Lost	Alarm: Default CAN bus failure
DOC	Diesel Oxidation Catalyst	
DPF	Diesel Particulate Filter	
ECU	Engine Control Unit	Engine governor
EGR	Exhaust Gas Recirculation	
ETC	Exhaust turbocharger	
FO	Frequency Output	
GND	Ground	
HI	High	Alarm: Measured value exceeds 1st maximum limit
HIHI	High High	Alarm: Measured value exceeds 2nd maximum limit
HP	High Pressure	
HT	High Temperature	
ID	Identification number	
IIG	Initiale Injektorgleichstellung	The injector code must be entered in the engine governor using DiaSys® to ensure optimum emissions and consumption characteristics.

Abbreviation	Meaning	Explanation
ISO	International Organization for Standardization	International umbrella organization for all national standardization institutes
ITS	Integrated Test System	
KGS	Kupplungsgegenseite	Engine free end in accordance with DIN ISO 1204
KS	Kupplungsseite	Engine driving end in accordance with DIN ISO 1204
LED	Light Emitting Diode	
LO	Low	Alarm: Measured value lower than 1st minimum limit
LOLO	Low Low	Alarm: Measured value lower than 2nd minimum limit
MTU	Motoren- und Turbinenunion	
MV	Magnetventil	Solenoid valve
OEM	Original Equipment Manufacturer	
OT	Oberer Totpunkt	Top Dead Center (TDC)
PAU	Power Automation Unit	Module for monitoring, control and plant-related system integration of peripheral components
PDU	Process Data Unit	
POM	Power Output Module	Module to control starter and battery-charging generator
PU	Projektierungsumgebung	Project engineering environment
P-xyz	Pressure-xyz	Pressure measuring point xyz
SAE	Society of Automotive Engineers	U.S. standardization organization
SAM	Service and Automation Module	
SD	Sensor Defect	Alarm: Sensor failure
SPC	Spare Parts Catalog	
SS	Safety System	Safety system alarm
TBO	Time Between Overhauls	
TC	Tool Catalog	
TEN	Technical Evolution Network	Technical sales documents, engine data, technical data
T-xyz	Temperature-xyz	Temperature measuring point xyz
U	Symbol for electric voltage	
UIC	Union Internationale des Chemins de Fer	International railway association
Ultra-Caps	UltraCaps modules	Capacitors for starting system
UT	Unterer Totpunkt	Bottom Dead Center (BDC)

8.2 MTU contact persons/service partners

Our worldwide sales network with its subsidiaries, sales offices, representatives and customer service centers ensures fast and direct support on site and the high availability of our products.

Local support

Experienced and qualified specialists place their knowledge and expertise at your disposal.

For locally available support, go to the MTU Internet site: <http://www.mtu-online.com>

24h hotline

With our 24h hotline and the outstanding flexibility of our service staff, we are always ready to assist you – either during operation, for preventive maintenance, corrective work in case of malfunction or changed operating conditions, or for spare parts supply.

Your contact person in our Customer Assistance Center:

E-mail: info@mtu-online.com

Tel.: +49 7541 9077777

Fax: +49 7541 9077778

Asia/Pacific: +65 6100 2688

North and Latin America: +1 248 560 8000

Spare parts service

Fast, simple and correct identification of spare parts for your drive system or vehicle fleet. The right spare part at the right time at the right place.

With this aim in mind, we can call on a globally networked spares logistics system, a central warehouse at headquarters and on-site stores at our subsidiary companies, agencies and service workshops.

Your contact at Headquarters:

E-mail: spare.parts@mtu-online.com

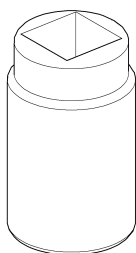
Tel.: +49 7541 908555

Fax: +49 7541 908121

9 Appendix B

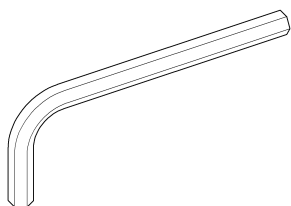
9.1 Special Tools

Adapter



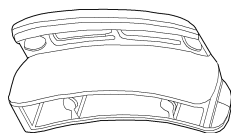
Part No.:	F30011619
Qty.:	1
Used in:	4.8 Engine – Barring manually (→ Page 34)

Allen key, 5 mm



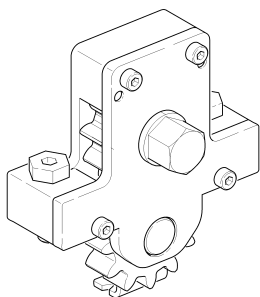
Part No.:	F30002815
Qty.:	1
Used in:	7.1.1 Valve clearance – Check and adjustment (→ Page 83)

Assembly jig



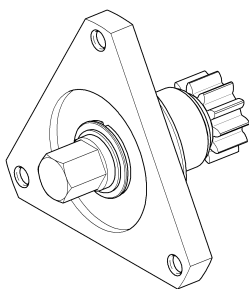
Part No.:	F6794712
Qty.:	1
Used in:	7.10.1 Coolant pump – Drive belt replacement (→ Page 113)

Barring device



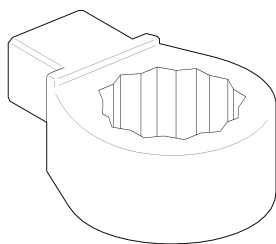
Part No.:	F6790714
Qty.:	1
Used in:	4.8 Engine – Barring manually (→ Page 34)
Qty.:	1
Used in:	7.1.1 Valve clearance – Check and adjustment (→ Page 83)

Barring device



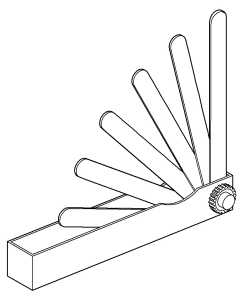
Part No.:	F6797426
Qty.:	1
Used in:	4.8 Engine – Barring manually (→ Page 34)

Box wrench, 14 mm



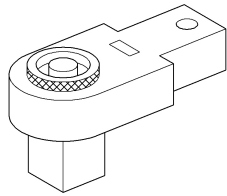
Part No.:	F30028346
Qty.:	1
Used in:	7.1.1 Valve clearance – Check and adjustment (→ Page 83)

Feeler gauge



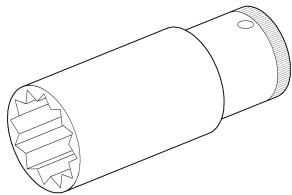
Part No.:	Y20010128
Qty.:	1
Used in:	7.1.1 Valve clearance – Check and adjustment (→ Page 83)

Ratchet adapter



Part No.:	F30027340
Qty.:	1
Used in:	4.8 Engine – Barring manually (→ Page 34)
Qty.:	1
Used in:	7.2.1 Fuel system – Venting (→ Page 87)
Qty.:	1
Used in:	7.3.1 Fuel filter – Replacement (→ Page 89)
Qty.:	1
Used in:	7.3.3 Fuel prefilter – Filter element replacement (→ Page 92)
Qty.:	1
Used in:	7.7.1 Engine oil filter – Replacement (→ Page 99)
Qty.:	1
Used in:	7.11.1 Battery-charging generator – Belt tensioner and diverter pulley replacement (→ Page 115)
Qty.:	1
Used in:	7.14.4 NOx sensor – Replacement (→ Page 123)
Qty.:	1
Used in:	7.14.5 Lambda sensor – Replacement (→ Page 125)

Socket, 32 mm

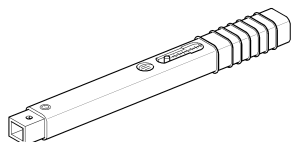


Part No.:	F30006120
Qty.:	1
Used in:	7.3.1 Fuel filter – Replacement (→ Page 89)
Qty.:	1
Used in:	7.7.1 Engine oil filter – Replacement (→ Page 99)

Steam jet cleaner

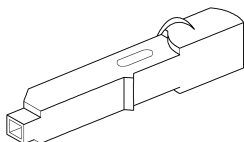
Part No.:	-
Qty.:	1
Used in:	4.7 Plant – Cleaning (→ Page 33)

Torque wrench, 20–100 Nm



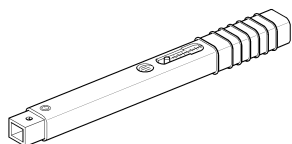
Part No.:	F30026582
Qty.:	1
Used in:	7.1.1 Valve clearance – Check and adjustment (→ Page 83)
Qty.:	1
Used in:	7.3.1 Fuel filter – Replacement (→ Page 89)
Qty.:	1
Used in:	7.11.1 Battery-charging generator – Belt tensioner and diverter pulley replacement (→ Page 115)
Qty.:	1
Used in:	7.14.4 NOx sensor – Replacement (→ Page 123)
Qty.:	1
Used in:	7.14.5 Lambda sensor – Replacement (→ Page 125)

Torque wrench, 4–20 Nm



Part No.:	F30044239
Qty.:	1
Used in:	7.2.1 Fuel system – Venting (→ Page 87)
Qty.:	1
Used in:	7.3.1 Fuel filter – Replacement (→ Page 89)

Torque wrench, 8–40 Nm



Part No.:	F30043446
Qty.:	1
Used in:	7.3.3 Fuel prefilter – Filter element replacement (→ Page 92)
Qty.:	1
Used in:	7.7.1 Engine oil filter – Replacement (→ Page 99)

9.2 Index

A

- Abbreviations 127
- Actuators
 - Overview 18
- After stopping the engine 32
- Air filter
 - Replacement 95
 - Service indicator check 96
- Air filter element
 - Cleaning 94
 - Removal and installation 93

B

- Battery-charging generator
 - Belt tensioner
 - Replacement 115
 - Diverter pulley
 - Replacement 115
 - Drive belt
 - Installation 117
 - Removal 117
- Belt tensioner
 - Replacement
 - On battery-charging generator 115

C

- CDC
 - Reset 120
- Charge-air coolant
 - Change 108
 - Draining 109
 - Filling 110
- Charge-air coolant level
 - Check 107
- Charge-air coolant pump
 - Drive belt
 - Replacement 113
 - Relief bore check 112
- Connectors
 - Cleaning 121
- Contact persons 129
- Coolant
 - Change 101, 108
- Coolant level
 - Check 100
- Coupling
 - Checking radial/axial play 118
- Cylinder
 - Designation 16
- Cylinder head cover
 - Installation 86
 - Removal 86

D

- Diverter pulley
 - Replacement
 - On battery-charging generator 115
- Drift correction parameters
 - Reset 120
- Drive belt
 - Charge-air coolant pump
 - Replacement 113
 - Engine coolant pump
 - Replacement 113
 - Installation
 - On battery-charging generator 117
 - Removal
 - On battery-charging generator 117
- Dust bowl
 - Cleaning 94

E

- ECU 9
 - Fault messages 40
- Engine
 - Barring manually 34
 - Overview 17
 - Start 29
 - Stop 31
- Engine cabling
 - Check 119
- Engine coolant
 - Change 101
 - Check
 - Level at filler neck 100
 - Level with level sensor 100
 - Draining 102
 - Filling 104
- Engine coolant level
 - Check 100
- Engine coolant pump
 - Drive belt
 - Replacement 113
 - Relief bore check 106
- Engine driving end
 - Definition 16
- Engine free end
 - Definition 16
- Engine governor
 - Cleaning 121
 - Plug-in connections
 - Check 122
- Engine oil
 - Change 98
- Engine oil filter
 - Replacement 99
- Engine oil level
 - Check after stopping the engine 97
 - Check prior to engine start 97

- Engine sides
 - Designation 16

F

- Fault messages
 - ECU 9 40
- Filter
 - Fuel
 - Replacement 89
- Fuel filter
 - Replacement 89
- Fuel prefilter
 - Filter element replacement 92
- Fuel prefilter
 - Drain condensate 91
- Fuel system
 - Venting 87

H

- Hotline 129

I

- IIG
 - Input 120
- Injector coding
 - Input 120
- Injector functions 120

L

- Lambda sensor
 - Replacement 125

M

- Main engine dimensions 23
- Maintenance schedule
 - Maintenance task reference table [QL1] 36
- MTU contact persons 129

N

- NOx sensor
 - Replacement 123

O

- Operational checks 30
- Overview
 - Actuators 18
 - Sensors 18

P

- Plant
 - Cleaning 33
- Plug-in connections
 - Check
 - On engine governor 122
- Product data
 - 12V1600R50 24

R

- Relief bore
 - Engine coolant pump - Check 106

S

- Safety notices, standards 15
- Safety regulations
 - Auxiliary materials 13
 - Environmental protection 13
 - Fire prevention 13
 - Fluids and lubricants 13
 - Important provisions 5
 - Maintenance work 10
 - Operation 9
 - Organizational requirements 7
 - Personnel requirements 7
 - Repair work 10
 - Startup 9
- Safety requirements
 - Safety notices, standards 15
- Sensors
 - Overview 18
 - Replacement
 - Lambda 125
 - NOx 123
- Service indicator
 - Check 96
- Service partners 129
- Spare parts service 129
- Startup
 - After extended out-of-service periods (>3 months) 28
 - After scheduled out-of-service-period 27

T

- Technical data
 - 12V1600R50 24
- Troubleshooting 37

V

- Valve clearance
 - Adjustment 83
 - Check 83

W

- Wiring
 - Check
 - On engine 119